DOCUMENT RESUME

ED 300 233 SE 049 748

AUTHOR	Carey, Neil B.; And Others
TITLE	Recruiting Mathematics and Science Teachers through Nontraditional Programs: A Survey. A RAND Note.
INSTITUTION	Rand Corp., Santa Monica, Calif.
SPONS AGENCY	Ford Foundation, New York, N.Y.
REPORT NO	N-2736-FF/CSTP
PUB DATE	May 88
NOTE	86p.; Tables with small print may not reproduce well.
AVAILABLE FROM	The RAND Corporation, Publications Department, 1700 Main Street, P.O. Box 2138, Santa Monica, CA 90406-2138 ($7.50; 25% discount for 25 or more copies).
PUB TYPE	Reports - Descriptive (141) -- Viewpoints (120)
EDRS PRICE	MF01 Plus Postage. PC Not Available from EDRS.
DESCRIPTORS	*Change Strategies; Demand Occupations; *Educational Demand; Elementary School Science; Elementary Secondary Education; Employment Patterns; *Incentives; Science Education; Secondary School Science; Teacher Employment; *Teacher Recruitment; *Teacher Shortage; *Teacher Supply and Demand

ABSTRACT

As the supply of mathematics and science teachers in the United States falls short of demand, there is a search for ways to increase the supply. The policy responses being tried include making all teaching positions more attractive through improved salaries and professionalization, offering general and targeted college scholarships and loans to ease entry into teaching, and reducing or restructuring teacher preparation programs and certificate requirements. This document discusses nontraditional recruitment policies that restructure teacher preparation programs to make them accessible to recent college graduates who have majored in science or mathematics, to persons changing careers, and to retired persons and homemakers. Some reduce preparation requirements, others maintain current standards but reduce the financial costs of preparation. Discussed are the dimensions of teacher shortages in science and mathematics, policy responses to the problem, issues for research, types of nontraditional programs, and options for alleviating shortages. Forty-four references are cited. (CW)

****
* Reproductions supplied by EDRS are the best that can be made *
* from the original document. *
****

SE

ED300233

A RAND NOTE

Recruiting Mathematics and Science Teachers Through Nontraditional Programs: A Survey

Neil B. Carey, Brian S. Mittman,
Linda Darling-Hammond

May 1988

U.S. DEPARTMENT OF EDUCATION
Office of Educational Research and Improvement
EDUCATIONAL RESOURCES INFORMATION CENTER (ERIC)

X This document has been reproduced as received from the person or organization originating it.

☐ Minor changes have been made to improve reproduction quality.

• Points of view or opinions stated in this document do not necessarily represent official OERI position or policy.

"PERMISSION TO REPRODUCE THIS MATERIAL IN MICROFICHE ONLY HAS BEEN GRANTED BY

Mona Allen

TO THE EDUCATIONAL RESOURCES INFORMATION CENTER (ERIC)."

SE 049 748

40 Years 1948-1988
RAND

The research described in this report was conducted in RAND's Center for the Study of the Teaching Profession under a grant from The Ford Foundation.

The RAND Publication Series: The Report is the principal publication documenting and transmitting RAND's major research findings and final research results. The RAND Note reports other outputs of sponsored research for general distribution. Publications of The RAND Corporation do not necessarily reflect the opinions or policies of the sponsors of RAND research.

Published by The RAND Corporation
1700 Main Street, P.O. Box 2138, Santa Monica, CA 90406-2138

A RAND NOTE

N-2736-FF/CSTP

Recruiting Mathematics and Science Teachers Through Nontraditional Programs: A Survey

Neil B. Carey, Brian S. Mittman,
Linda Darling-Hammond

May 1988

Prepared for
The Ford Foundation

40 Years 1948-1988
RAND

Center for the Study of
the Teaching Profession

FOREWORD

As the nation's supply of mathematics and science teachers falls short of demand, the search is on for ways to increase the supply. The policy responses being debated and tried include making all teaching positions more attractive through improved salaries and professionalization; offering general and targeted college scholarships and loans to ease entry to teaching; and reducing or restructuring teacher preparation programs and certification requirements.

This Note discusses nontraditional recruitment policies that restructure teacher preparation programs to make them accessible to recent college graduates who have majored in science or mathematics, to persons changing careers, and to retired persons and homemakers. Some of these policies reduce the preparation requirements for teaching; others maintain current standards but offer incentives that reduce the financial and other costs of preparation.

Nontraditional programs emerged as a response to the limitations of traditional programs. The traditional path to teaching has been through an undergraduate major in teacher education. The traditional path can generally only be followed by college students who decide as sophomores to become teachers. It limits access to teaching for those who at other ages or career stages would like to become teachers. Ironically, when shortages occur, many who are unable or unwilling to return to college enter teaching without preparation on emergency credentials.

Because some people decide late, because a shortage of mathematics and science teachers is developing, and because some do not believe that specific preparation for teaching is necessary, two policy directions have emerged. One direction denies the need for teacher preparation. The other underscores the importance of unbundling teacher preparation from the undergraduate curriculum.

Colleges of education should understand the significance of these developments and anticipate the policy and market environment that is emerging. If post-B.A. teacher preparation programs are institutionalized and advertised, they will provide access to teaching for a wide variety of people who decide to become teachers after their sophomore year of college. These programs will help to solve the developing shortage. And they will do so not by denying the importance of preparation for teaching but by making preparation available. If the quality of preparation is high, policymakers will see the importance of

preparing people for teaching. Otherwise, if teacher preparation consists only of on-the-job training, many school children will suffer as some candidates learn—and others fail to learn—how to teach.

Arthur E. Wise, Director
Center for the Study of the
Teaching Profession

PREFACE

This Note is a companion to the final report of a project entitled "A Study of New Recruits into Mathematics and Science Teaching," sponsored by The Ford Foundation. This project examined the role of teacher preparation programs in attracting and facilitating the entry of nontraditional recruits into mathematics and science teaching. The study had three major components. The first component, reported in this Note, included a survey of education agencies and teacher training institutions to identify and characterize nontraditional programs. This component identifies the range of recent initiatives directed toward nontraditional recruits and reports characteristics of and changes in these programs. The second component consisted of personal interviews and mail surveys of program administrators, participants, and graduates of a sample of selected nontraditional programs. Additional analyses included examination of existing longitudinal data on individuals in mathematical and scientific fields. These analyses examined occupational changes from other occupations into teaching to characterize an important segment of the teacher "reserve pool."

The Note should interest policymakers and educators who wish to learn more about the types of current initiatives for attracting nontraditional recruits into mathematics and science teaching. It should also be useful to administrators of teacher education programs who would like to better understand the factors influencing program success and longevity. It should be particularly useful to organizations interested in implementing similar nontraditional programs.

SUMMARY

In recent years, mounting shortages of precollegiate teachers, especially those qualified to teach mathematics and science, have raised considerable public concern. School districts are having to cope with these shortages in ways that compromise the quality of instruction offered to students: hiring uncertified teachers, assigning teachers outside their fields of preparation, cancelling course offerings, and expanding class sizes.

In response to these shortages, teacher training institutions, local school districts, and state education agencies and legislatures have implemented a variety of policies designed to increase the flow of new recruits into mathematics and science teaching. This Note describes an important subset of these policies: initiatives aimed at recruiting new teachers from nontraditional pools such as retirees, homemakers, career switchers, and recent college graduates with mathematics and science degrees. The goal of these initiatives is to expand the pool of entrants into mathematics and science teaching by easing barriers to entry, while maintaining certain standards.

As a policy strategy, adoption of these initiatives is based on the following set of hypotheses: (1) Potentially productive pools of recruits can be identified; (2) programs can be devised to meet their special needs; and (3) programs can be sustained long enough and can produce enough teachers to make a significant difference in the supply of recruits to mathematics and science teaching.

To shed light on these hypotheses, we surveyed 64 programs that (a) were partially or wholly aimed at preparing mathematics and science teachers for a credential, and (b) emphasized attracting nontraditional recruits (i.e., not undergraduate education majors). Specifically, three distinct types of programs were included in the survey:

- *Alternative certification programs* designed to increase the potential supply of teachers by creating alternative preparation routes that meet revised certification requirements.
- *Nontraditional recruitment programs* designed to provide potential teachers from nontraditional pools with the coursework and other requirements for full certification. These programs do not require changes in state policies regarding teacher training or licensure.

- *Retraining programs* designed to help certified teachers from other fields obtain endorsement or certification in mathematics and science.

Our study answered the following questions:

1. What kinds of preparation are offered by nontraditional programs of different types? How do programs differ in content and requirements?

We found large variations in the types of preparation offered, their content, and requirements. One central factor was the program's targeted recruit pool, since the design of a program is also closely tied to its applicant pool. Programs aimed at graduates with mathematics or science majors emphasize teaching methods courses and internships, whereas retraining programs designed for current teachers in other fields emphasize mathematics or science coursework. More subtle differences are seen in new-B.A. versus mid-career and retiree programs: Recent college students are more likely to adapt to regular college courses than mid-career changers and retirees. Programs aimed at the latter recruit pools generally include special courses whose content mirrors that of regular college courses, but which have been modified to fit better the experiences and schedules of mid-career and retiree participants.

2. What is the current enrollment of the nontraditional teacher preparation programs?

After a fairly exhaustive search, we found 64 programs that reported enrollments of 2443 prospective mathematics and science teachers in 1986-87. This does not represent the entire universe of such programs, but we believe it includes at least a majority of existing programs. Considering that over 20,000 new mathematics and science teachers will be needed each year over the next decade, these initiatives are responsible for providing a nontrivial fraction of the current total needed, perhaps as much as 20 percent. The proportion applied to particular localities may vary considerably. For example, some local and state programs we surveyed supplied as many as 15 to 30 percent of new teacher hires in those jurisdictions for certain subjects. Nevertheless, the programs can not, by themselves, attract enough participants to completely solve the expected nationwide shortage of qualified mathematics and science teachers. The rate at which programs are created, modified, and ended suggests that the share of teaching positions they help to fill will continue to be unpredictable, at least in the short term.

3. How successful have nontraditional programs been in attracting nontraditional participants such as recent math and science B.A.s, mid-career changers, retirees, current teachers desiring math/science certification, discharged military personnel, or homemakers?

Our study found that very few retirees participate in nontraditional programs. Programs that focus on retirees have quickly turned to other sources of participants to maintain their enrollments. Although there may be ways to tap this pool of potential workers for mathematics and science teaching, the current prospects are not encouraging.

We also found that few homemakers participate in nontraditional programs. This was not surprising, given that historically, relatively few women have majored in mathematical and scientific fields. Even those who once majored in education are unlikely to have degrees in mathematics or science specialties. Furthermore, homemakers are a shrinking pool from which to draw teachers, given the dramatic trend of women to stay in the workforce after having children. This evidence leads us to conclude that, at least currently, homemakers are a very limited source of potential mathematics and science teachers.

The pools for which nontraditional preparation programs may have the most promise as distinctive, long-lasting contributors are the mid-career changers and new B.A.s, since the programs we surveyed attracted members of these groups in large numbers. Mid-career changers and new B.A.s may also be the most sensitive to the financial and opportunity costs posed by traditional teacher education programs.

4. What are the economic and opportunity costs to individuals who participate in nontraditional programs?

Many nontraditional programs shift costs from participants to program sponsors. The programs we surveyed varied in their monetary costs to participants, ranging from no tuition to over $10,000. Programs differed considerably in their opportunity costs, as well—with programs taking from 16 weeks to three years to complete. Most retraining programs have assumed that current teachers are unwilling or unable to assume tuition costs to prepare for new teaching fields. Alternative certification programs seek to lower opportunity costs by allowing candidates to assume paid teaching positions without having to take substantial numbers of education courses beforehand.

5. Have there been recent changes in the programs' design or the target groups they enroll? If so, what sorts of changes have occurred and why?

Our study found that many programs change in response to the willingness of particular recruit pools to enter teaching and of local districts to hire new recruits. In particular, some programs that originally focused on retirees have already decided to look at mid-career changers and new B.A.s as more ready sources of applicants. Other programs that originally focused exclusively on mathematics and science have opened to applicants in other subject areas. The pressure to attract applicants from a wide range of sources to keep enrollment up, and the pressure to be responsive to quickly changing district needs, provide incentives to broaden the programs' emphases. This broadening results in loss of identity with particular applicant pools or subject matters.

6. Which types of programs have survived and maintained their enrollments? What are the conditions that appear to threaten or enhance the viability of different program types?

Generally, programs that have survived and maintained their enrollments have done so by remaining flexible in how they seek funding, in who they recruit, and in how they package their program. Several programs survived with different names and new funding sources even though particular important sponsors withdrew support. Furthermore, we observed that teacher labor markets are still largely local; thus, local school districts' needs and practices and local economic conditions influence programs substantially.

Our findings suggest that several factors affect a program's enrollment and success in remaining viable: (1) the state of the local economy, (2) local demand for mathematics and science teachers, and (3) program funding. We conclude that (a) nontraditional programs may be most successful at attracting new mathematics and science teachers in times of high or rising unemployment in math/science fields outside of education; and (b) programs are more successful when they are planned with a clear understanding of and relationship to the needs of local school districts.

ACKNOWLEDGMENTS

We would like to thank RAND colleague Arthur E. Wise for his thoughtful and encouraging comments on an early draft of this report. Sheila Kirby and Lisa Hudson assisted in all phases of the research and contributed more to this study than they realize. Special thanks are due to Gail Zellman for her thorough and constructive reviews of the work as it progressed. We thank our survey respondents, who answered our many followup questions with good humor. We are especially grateful to the many program heads who, without being asked, shared insights and further information that contributed greatly to the quality of our study. Finally, we thank Sally Belford for her superb work on the data tables, Luetta Pope for her excellent typing, and Patricia Bedrosian for her patient and careful editing. Any errors that remain are the responsibility of the authors.

CONTENTS

FOREWORD iii

PREFACE v

SUMMARY vii

ACKNOWLEDGMENTS xi

FIGURE AND TABLES xv

Section
I. INTRODUCTION 1
Dimensions of the Current Math/Science Teacher Shortage 2
Policy Responses to Teacher Shortages 6

II. RESEARCH ISSUES 11
Previous Research 12
Research Questions 15
Survey Approach and Methods 16

III. A TYPOLOGY OF NONTRADITIONAL RECRUIT PROGRAMS 20
Alternative Certification Programs 20
Nontraditional Recruitment Programs 30
Retraining Programs 46

IV. SUMMARY AND CONCLUSIONS 58
Types of Preparation Programs 59
Current Enrollments in Nontraditional Programs 60
Success in Attracting Nontraditional Participants 60
Changes in Program Design or Target Groups 63
Factors Influencing Program Viability 64
Options for Alleviating Mathematics and Science Teacher Shortages 65

APPENDIX 69

REFERENCES 71

FIGURE

1. Math and science teachers: entrants and attrition 4

TABLES

1. Estimated Supply of New Teacher Graduates Compared to Estimated Demand in Regular Private and Public Elementary and Secondary Schools 3
2. Relative Demand for Teachers by Teaching Area 5
3. Status of States Concerning Alternatives to Teacher Education: 1986 13
4. Summary of Programs in Survey Sample: 1986-87 21
5. Alternative Certification Programs: 1986–87 22
6. Nontraditional Recruitment Programs: New And Recent B.A.s, 1986–1987 33
7. Nontraditional Recruitment Programs: Mid-Career Changers, 1986–87 ... 38
8. Nontraditional Recruitment Programs: Retirees, 1986–87 42
9. Retraining Programs: 1986-87 47

I. INTRODUCTION

In recent years, mounting shortages of precollegiate teachers, especially those qualified to teach mathematics and science, have raised considerable public concern (National Science Board, 1983; Darling-Hammond, 1984; Shymansky and Aldridge, 1982; Carnegie Forum, 1986). Just as a series of national commission reports have pointed to the need for improving the quality of mathematics and science teaching in our nation's schools (National Commission on Excellence in Education, 1983; National Science Board, 1983), school districts are having to cope with these shortages in ways that compromise the quality of instruction offered to students: hiring uncertified teachers, assigning teachers outside their fields of preparation, cancelling course offerings, and expanding class sizes.

In response to these shortages, teacher training institutions, local school districts, and state education agencies and legislatures have implemented a variety of policies designed to increase the flow of new recruits into mathematics and science teaching. This Note describes an important subset of these policies: initiatives aimed at recruiting new teachers from nontraditional pools such as retirees, homemakers, career switchers, and recent college graduates with mathematics and science degrees. The goal of these initiatives is to expand the pool of entrants into mathematics and science teaching by easing barriers to entry, while maintaining standards. They provide varying kinds and amounts of preparation for teaching to candidates who have not gone through traditional undergraduate teacher education programs.

Nontraditional teacher preparation programs focus on one aspect of the complex set of forces that produce teacher shortages: the apparent inability of traditional undergraduate teacher education programs to secure enough candidates to meet the need for mathematics and science teachers. The theory behind these alternative programs is that there are potential teacher recruits outside the undergraduate student population who can be persuaded to complete teacher preparation if programs are targeted to their needs and the costs of preparation are reduced. Other dimensions of the shortage problem—competition for talent with other labor market sectors, salary differentials, and the attractiveness of teaching work—are not directly addressed by these initiatives, although these factors obviously influence the decisions of potential recruits and the success of these programs at meeting their goals.

This Note describes the range of nontraditional preparation programs recently created to increase the supply of mathematics and science teachers. It examines what pools of recruits they tap, how many prospective teachers they prepare, and what forces in their environments influence their success and long-run viability. The Note concludes with recommendations for administrators and policymakers wishing to use limited teacher recruitment and training resources effectively.

DIMENSIONS OF THE CURRENT MATH/SCIENCE TEACHER SHORTAGE

Current shortages of mathematics and science teachers are related to a more general decline in teacher supply which began during the 1970s. Between 1970 and 1980, the proportion of college students majoring in education declined by nearly half—from 21 percent to 11.6 percent. By 1984, the proportion had slipped to only 9 percent (CES, 1987). In numerical terms, this represents a drop in the supply of new teacher education majors from nearly 177,000 in 1970 to 88,000 in 1984-85.

Meanwhile, demand for new teachers began to rise in the early 1980s, because of increasing teacher retirements and increasing enrollment as the children of the baby boom generation began to enter school (Darling-Hammond, 1984; CES, 1985). The Center for Education Statistics has projected that the demand for additional teachers will range between about 160,000 and 230,000 annually over the next five years (CES, 1985). Thus, the gap between the supply of newly trained teachers and the demand for additional teachers is substantial; new teachers may constitute less than two-thirds of the number needed by 1992 (Table 1). If classrooms are to be filled with qualified teachers, large numbers will need to be recruited from sources other than undergraduate teacher education programs.

Declines in the numbers of college students majoring in mathematics or science education have been equally severe. Between 1971 and 1982, the number of students graduated with a bachelor's degree in mathematics education dropped from 2217 to 672, although it inched up to 775 by 1983-84. Declines in the number of science education graduates were less substantial but still severe—from 891 in 1971 to 597 in 1981. Since then, the number of graduates has increased to 702 in 1983-84 (CES, 1987). These numbers are contrasted graphically to the demand for replacement teachers in Fig. 1, which suggests that, in 1982, as many as 12 mathematics and science teachers left the profession for every new mathematics or science education graduate prepared to enter.

Students majoring in education are not the only source of new teacher supply. Many individuals who receive certification have majored in the subject areas they intend to teach, taking certification courses on the side or in master's degree programs. This may be the

Table 1

ESTIMATED SUPPLY OF NEW TEACHER GRADUATES COMPARED TO ESTIMATED DEMAND IN REGULAR PRIVATE AND PUBLIC ELEMENTARY AND SECONDARY SCHOOLS
(In thousands)

Year	Supply of New Teachers		Demand for Additional Teachers		Supply as a Percent of Demand	
Estimates of Actual Supply and Demand						
1980	144		127		113.4	
1981	141		110		128.2	
1982	143		143		100.0	
Estimates of Future Supply and Demand: Intermediate Alternative Projections (and Low-High Range)						
1983	146	(132-155)	148	(97-215)	98.6	(61.4-159.8)
1984	146	(126-160)	142	(98-206)	102.8	(61.2-163.3)
1985	144	(121-163)	157	(115-225)	91.7	(53.8-141.7)
1986	142	(115-165)	170	(121-232)	83.5	(49.6-136.4)
1987	140	(110-168)	160	(113-229)	87.5	(48.0-148.7)
1988	139	(107-171)	164	(115-231)	84.8	(46.3-148.7)
1989	139	(105-176)	173	(125-247)	80.3	(42.5-140.8)
1990	139	(102-181)	183	(136-264)	76.0	(38.6-133.1)
1991	138	(100-184)	195	(141-233)	70.8	(42.9-130.5)
1992	137	(99-188)	209	(157-231)	65.6	(42.9-119.7)

SOURCE: CES (1985), Table B-23.

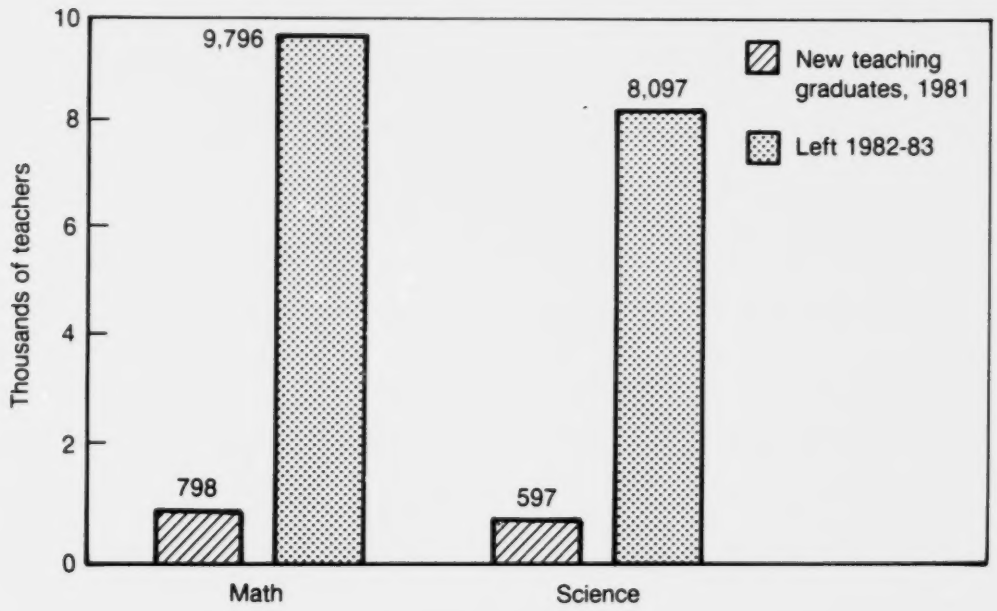
case for as many as three-quarters of secondary mathematics and science teachers (Rumberger, 1985). Nonetheless, shortages of mathematics and science teachers have been pronounced in recent years, and some evidence suggests that such shortages have existed to varying degrees for several decades (Levin, 1985).

Although shortages of mathematics and science teachers grow more or less acute with trends in the teaching force as a whole, they are a more constant problem. Declines in the number of entrants to teaching throughout the 1970s did not cause general shortages during that time (because elementary and secondary school enrollments were declining at the same time and relatively few teachers were leaving), but shortages of mathematics and science teachers were evident then even when there were surpluses of teachers in other fields. Over the ten years from 1976 to 1986, the Association for School, College, and University Staffing (ASCUS) surveys show mathematics leading the list of shortage fields, followed closely by physics and chemistry (Table 2). National surveys of 50 state science supervisors in 1980, 1981, and 1982 revealed severe and worsening shortages in mathematics and physics (Howe and Gerlovich, 1982). A survey by the Education

Commission of the States in 1983 found that only five states had no shortages in science, whereas 35 states reported shortages in mathematics.

Although relatively few teaching vacancies remain unfilled, school districts have increasingly relied on emergency certification procedures and out-of-field teachers in staffing mathematics and science classes (Darling-Hammond and Hudson, 1987). For example, a survey of secondary school administrators showed that about half of all newly hired science and mathematics teachers in 1981 were not certified to teach in these areas (Shymansky and Aldridge, 1982). A 1981 survey of recent college graduates reinforced this finding: Only 44 percent of those teaching mathematics and science were certified or eligible for certification in their current fields of assignment (Plisko, 1983). Thus, although data on the exact dimensions of math/science teacher shortages remain unavailable, the evidence consistently indicates that shortages of qualified mathematics and science teachers are real and significant.

Several trends are expected to exacerbate these shortages. Recent reports on the condition of American education have concluded that the quality of scientific instruction must improve, suggesting that the United States will not be able to compete successfully in



SOURCE: Darling-Hammond (1984).

Fig. 1—Math and science teachers: entrants and attrition

the increasingly technological world economy without better training for more students in mathematics and science (Ramo, 1983; Boyer, 1983; National Commission on Excellence in Education, 1983; National Science Board, 1983). As a result, many states have enacted legislation increasing the mathematics and science requirements for secondary school graduation, further increasing the demand for teachers, particularly well-trained teachers who can teach more advanced courses in these fields.

Meanwhile, the increasing demand for scientific and technically trained persons in many sectors of the American economy means that teaching must increasingly compete with other occupations for the dwindling supply of college graduates trained in mathematics and science-related fields. Even as the number of jobs for such technically trained individuals has increased, the number of bachelor's and master's degrees awarded in mathematics and

Table 2

RELATIVE DEMAND FOR TEACHERS BY TEACHING AREA
(5 = greatest demand, 1 = least demand)

Field	1986	1985	1984	1983	1982	1981	1976
Teaching Fields with Considerable Teacher Shortages (5.00-4.25)							
Mathematics	4.45	4.71	4.78	4.75	4.81	4.79	3.86
Science—Physics	4.44	4.57	4.45	4.46	4.41	4.56	4.40
Science—Chemistry	4.40	4.42	4.25	4.30	4.13	4.42	3.72
Bilingual Ed.	4.27	4.12	4.04	3.83	4.13	4.10	N/A
Special Ed.—Mult. Handicapped	4.25	3.94	3.77	3.82	3.93	4.13	N/A
Special Ed.—MR	4.25	3.76	3.55	3.71	3.84	4.14	2.87
Teaching Fields with Some Teacher Shortage (4.24-3.45)							
Computer Science	4.22	4.37	4.34	N/A	N/A	N/A	N/A
Special Ed.—ED/PSA	4.20	4.02	3.84	4.08	3.98	4.22	3.42
Speech Pathology/ Audio.	4.09	4.01	3.83	3.62	3.95	4.27	3.68
Data Processing	3.97	4.30	4.18	4.36	3.86	N/A	N/A
Special Ed.—Gifted	3.91	3.85	3.74	3.80	3.81	4.10	3.85
Science—Earth	3.86	3.79	3.70	3.80	3.89	4.08	3.44
Science—General	3.82	3.65	3.65	N/A	N/A	N/A	N/A
Science—Biology	3.65	3.58	3.40	4.10	3.66	3.98	2.97
Language, Mod.— Spanish	3.64	3.43	3.18	2.77	2.68	2.95	2.47
Special Ed.— Reading	3.46	3.39	3.48	3.39	3.73	4.21	3.96

SOURCE: ASCUS (1986).

the life sciences fell by about 25 percent between 1975 and 1985, offset by only slight increases in the numbers of physical science degrees (CES, 1987). As competition for these graduates grows more intense, the already substantial wage differentials between teaching and other occupations are likely to grow even larger, making recruitment of mathematics and science teachers still more difficult.

Finally, evidence that recent recruits to teaching have come disproportionately from the less well-prepared segments of the college-going population (Weaver, 1978; Vance and Schlechty, 1982; Carnegie Forum, 1986) has raised concerns about teacher quality. These concerns have led, in turn, to state efforts to raise admissions requirements for teacher education programs and to require tests for certification (Darling-Hammond and Berry, 1988). Increased entry requirements may exclude many potential teachers whose qualifications would have been sufficient under earlier standards but not under the higher standards presently being implemented.

These recent conditions exacerbate longstanding ones that have made recruitment of mathematics and science teachers a more constant problem for schools than recruitment of other teachers. These constant factors include (1) the larger wage differentials that have existed between teacher salaries and wages for college graduates trained in mathematics and scientific fields; (2) the relatively small and increasingly inadequate numbers of college students majoring in these fields; and (3) the underrepresentation of women and minorities in these fields, given that these groups are overrepresented in the teaching force. In short, the female-dominated occupation of precollegiate teaching has for some time had difficulty attracting the small number of (predominantly male) college graduates trained in mathematics and science, whose alternative occupational opportunities offer much greater pecuniary rewards.

This combination of forces has led to a search for strategies to increase the numbers and sources of recruits to teaching generally, and to mathematics and science teaching in particular. It is in this context that nontraditional preparation programs aimed at different pools of potential recruits to teaching must be examined.

POLICY RESPONSES TO TEACHER SHORTAGES

Teacher shortages such as those described above are not without precedent in the U.S. public education system: serious shortages of public school teachers occurred in the 1920s and 1950s (Sedlak and Schlossman, 1986; Klausmeier, 1987). Indeed, Sedlak and Schlossman note that "Contrary to what many modern-day educators tend to assume, teacher shortages have been commonplace throughout the twentieth century" (1986, p. 39).

Although data regarding the 1920s shortages are limited, available evidence suggests that changes in salaries were largely responsible for both the shortage and its resolution: real teaching salaries declined by over 20 percent between 1914 and 1922, whereas they increased by almost 100 percent between 1920 and 1930 (Sedlak and Schlossman, 1986). Both economic changes and shifts in demography appear to have contributed to the resolution of 1950s shortages (Kershaw and McKean, 1962; Sedlak and Schlossman, 1986). Policy responses by state and local education agencies and by institutions providing teacher education were also important factors, however (Klausmeier, 1987). Programs proposed or implemented in response to teacher shortages included emergency transfers of teachers from nonshortage fields to those facing shortfalls; implementation of emergency credentialing programs which waived normal requirements for certification; financial and other incentives designed to increase enrollment in undergraduate education programs; programs to provide refresher courses for teachers who had previously left the teaching profession; and large-scale industry/school recruitment campaigns (Klausmeier, 1987).

Clearly these policy responses embody different views of the causes of shortages, and they emphasize different values in the resolution of the problem. Out-of-field assignment and emergency credentialing programs devalue the importance of teacher preparation by abandoning requirements in favor of staffing classrooms with whomever is willing and available. Salary hikes and financial aid for teacher education candidates seek, by contrast, to increase the attractions to teaching in hopes of increasing the supply of qualified entrants. Recruitment campaigns hope that by advertising the need for teachers, more interest in the occupation will be generated among otherwise undecided potential candidates.

Evidence from past shortages generally indicates that teacher education requirements and certification standards have been raised and lowered according to the supply/demand conditions facing teacher recruitment agencies (Weaver, 1978). Sedlak and Schlossman's (1986) analysis of 1950s shortages suggests that raising certification standards during those years had an immediate—and positive—impact on the education levels of teachers. They conclude that it was possible to raise standards during a shortage—but warn that the 1950s was a time when teacher working conditions and salaries were also improving.

The causes of and proposed solutions to current shortages reflect both longstanding problems buffeting the teaching profession and more recent social trends. Teachers have long been paid less than similarly educated individuals in other occupations (NEA, 1983; Darling-Hammond, 1984); however, teaching was able to attract large numbers of talented women and minorities for whom other career opportunities were closed. Greater equality of educational and occupational opportunities over the last decade has reduced the captive labor

force for teaching. Salary differentials and more attractive working conditions are attracting increasing numbers of academically talented women and minorities to other occupations. For example, the proportion of female college graduates receiving bachelor's degrees in education decreased from 36 percent to 16 percent between 1970 and 1984, whereas the proportion receiving degrees in the biological sciences, computer sciences, engineering, and law increased more than tenfold (Darling-Hammond, 1984; CES, 1987). Effective solutions to today's shortages will need to take into account the increased competition with other occupations for the pools of college graduates previously claimed by teaching.

Current Policy Initiatives

Policy responses to current shortages resemble 1950's responses in several ways, but they differ with respect to the role of teacher education programs in recruiting new entrants to teaching. As in earlier periods of shortage, salaries for teachers have increased after many years of decline. Between 1980 and 1985, average teacher salaries increased by over 30 percent; however, in real dollar terms, this barely returned salaries to the level they had reached in 1972 (Darling-Hammond and Berry, 1988). Many states have instituted financial incentives such as reduced rate or forgivable loans to attract more college students to education as a field of study and eventual career.

Other current efforts range from initiatives whose effects are long-term and uncertain, such as programs intended to improve the image of the teaching profession among current and potential teachers, to initiatives with immediate and clear results, such as changes in state credentialing requirements allowing uncertified individuals to teach in the classroom while enrolled in teacher training or retraining programs (Darling-Hammond and Berry, 1988; Hawley, 1986).

Still other initiatives are aimed at improving the quality of existing mathematics and science teaching, such as in-service workshops and joint industry-school programs which provide scientists and engineers to lend homework assistance, to serve as guest lecturers, or to serve as temporary teachers. Some joint industry-school programs provide summer employment in business and industry for full-time teachers, thereby giving them an opportunity to earn additional salary during the summer and interact with individuals applying mathematics and science in other occupations. This may also have the beneficial effect of allowing teachers to understand better the kinds of skills required in industry and business, helping them to structure their classes in more relevant ways. However, although programs designed to improve the quality of fully certified mathematics and science teachers are important, they do not address the overall problem of teacher recruitment.

What sets nontraditional teacher preparation programs apart from these other initiatives and from previous attempts to resolve teacher shortages is that they seek to find a compromise between competing demands for quality and for quantity. That is, they attempt to find, recruit, and prepare for teaching careers individuals who are not attracted to traditional preparation programs, while maintaining the requirement that these recruits be certified to teach their subjects.

Nontraditional Teacher Preparation Programs

Whereas earlier responses to teacher shortages either relied on efforts to attract recruits to traditional teacher education programs or skirted these programs entirely by allowing the hiring of uncertified entrants, nontraditional initiatives seek to eliminate the characteristics of traditional teacher education programs that may limit the numbers and quality of college students they attract.

There are several ways in which traditional undergraduate programs may limit the supply of potential recruits to teaching. First, undergraduate teacher education programs typically require a large number of courses and hence an early commitment to a college major. Teaching poses opportunity costs with respect to the other course work (and career) options available to college students at a very early point in the higher education process. Thus, individuals who are not ready to commit to a teaching career by their junior year in college may be lost to teaching even if they later decide they are interested in such a career, unless opportunities for acquiring the training needed for certification are available outside the context of undergraduate programs.

Second, financial support for teacher education students is limited and anticipated salaries are low; thus, the costs of preparation may not be viewed as commensurate with the earnings potential, and recruits may be reluctant to assume debt that they will be in relatively poor position to pay off later. Also, the amount of time needed to secure a teaching credential in a traditional program may dissuade potential recruits who must forgo earnings while in training. Finally, the relatively low status enjoyed by traditional teacher preparation programs on college campuses may dissuade some candidates from entering these programs if they fear the coursework or the ensuing credential may be of limited value in the marketplace or in their future careers.

Alternative programs aimed at college graduates are able to draw some of these individuals into teaching despite their failure to decide on a teaching career while still in college. These programs seek to lower the costs associated with pursuing a teaching credential by providing financial aid for recruits, reducing the time needed to complete

training, and targeting courses at the specific needs of specific groups of potential recruits (e.g., providing education courses for those with the requisite subject matter background or providing subject matter courses for those with the requisite education background). Individuals who have pursued other activities (other jobs, further education, homemaking) and then decide they would like to try teaching may be unwilling to re-enroll in undergraduate programs to acquire the teacher training necessary for certification. Alternative programs that lessen the time and cost of entry into teaching, however, might lead such individuals to change their careers and enter the teaching profession.

Available data are scarce, but statistics on the characteristics of new entrants to the teaching profession suggest that programs targeted at nontraditional pools may be an important means of increasing the supply of teachers. The proportion of new entrants to teaching who had been attending college the previous year declined from 67 percent in 1966 to 16 percent in 1986 (NEA, 1987). Thus, most of the teachers hired in 1986 came from sectors of the labor force other than recent college graduates. Fifteen percent of these new entrants had been working in nonteaching positions in the previous year; 28 percent had been homemakers; 2 percent had been unemployed or retired; and the remainder were engaged in other pursuits during the previous year. Although these statistics do not reveal whether the new entrants had previously received teacher training (and merely bided time in other jobs or elected to leave the labor market for a year or more), they do suggest that individuals may enter or return to teaching after pursuing other occupations. The hope is that some of them might be encouraged to enter mathematics or science teaching if such entry is made easier.

This Note presents data on a sample of programs that are designed to attract and train such nontraditional recruits to teach mathematics and science in elementary or secondary schools. We define the term "nontraditional" to include current teachers not certified in mathematics and science, recent college graduates who did not major in education, and other nontraditional entrants such as individuals with technical backgrounds in science or mathematics who are currently working in occupations outside education.

The next section discusses previous research on nontraditional teacher training programs and outlines the research issues that this Note attempts to address. The criteria and methodology used in the study are also outlined in Sec. II. Programs that constituted our final sample were characterized according to a typology developed to highlight similarities and differences among programs; this is discussed in Sec. III, along with important characteristics of the programs themselves. The final section presents our conclusions.

II. RESEARCH ISSUES

Most nontraditional preparation programs have focused on preparing college graduates for teaching fields in which shortages have become acute, particularly mathematics and science. These programs use several different strategies to identify and train teachers for mathematics and science positions, each of which embodies a different notion of preparation and targets different pools of prospective mathematics and science teachers. Program sponsors and goals also vary depending on the type of recruit and type of preparation emphasized. Some programs identify particular pools of recruits (e.g., current teachers of other subjects, or technically trained individuals in nonteaching careers) and tailor training to meet their needs. Others respond to state-inititated changes in certification requirements which specify the type and minimum amounts of coursework needed to obtain a special, or alternative, teaching certificate.

Although differing in their specific approaches, the programs share the goal of seeking to lower the transaction costs for preparation. The financial costs of training, though, are not necessarily reduced overall; they are more often shifted to sponsors rather than being assumed by the candidates themselves. Thus, state agencies, school districts, and foundation or corporate donors support the costs of offering scholarships, loans, internship opportunities, or subsidized coursework. As a policy strategy, adoption of these programs is based on the following set of hypotheses: (1) Potentially productive pools of recruits can be identified; (2) programs can be devised to meet their special needs; and (3) programs can be sustained long enough and can produce enough teachers to make a significant difference in the supply of recruits to mathematics and science teaching. A corollary is that the benefits of the programs will be great enough for their sponsors (state governments, school districts, and training institutions) that they will continue to shoulder program costs for these initiatives.

Although the number and types of nontraditional programs have increased dramatically in recent years, little is yet known about the characteristics of these programs, their recruit pools, and their successes in placing candidates in teaching jobs. Below we summarize the several small-scale studies that have examined nontraditional programs; we then outline the research questions suggested by these studies and by our own research agenda.

PREVIOUS RESEARCH

Nationwide, scholarships, retraining of current teachers, and alternative certification routes have all been used as methods of dealing with shortages of mathematics and science teachers. According to a recent survey by the American Association of Colleges of Teacher Education (AACTE, 1986), loans and scholarships have been the most prevalent initiatives directed specifically toward mathematics and science teachers. Alternative certification routes have more often been directed toward teachers in all subject areas. The number of states offering alternative certification has jumped from eight in 1984 to 23 in 1986 (Table 3).[1]

Adelman (1986) identified 20 nontraditional teacher training programs nationwide[2] and conducted in-depth studies of ten: seven alternative certification and three retraining programs. She defined alternative certification as "programs designed to attract and prepare college educated but uncertified individuals for the teacher profession" and retraining as "programs that address particular state and local teacher recruitment needs by preparing fully certified teachers for recertification in a new field." Adelman's studies included telephone interviews of program administrators, program participants and their supervisors, and experienced teachers who had knowledge of the participants.

Most of the programs described by Adelman were in their infancy, so little conclusive evidence about the programs' outcomes could be collected. On the basis of the limited indicators available, Adelman drew several conclusions from her study. First, the alternative certification programs seemed to attract many well-educated individuals who appeared to be committed to teaching. These programs could be completed in a shorter time frame than traditional education programs, as they featured less coursework and more field

---

[1]Table 3 data were collected in the summer of 1986. Since this was a period of rapid change, these data may have changed in certain states.

[2]The 20 programs were the Arizona Partners Project, University of Massachusetts Math/English/Science/Technology (MESTEP) Project, George Mason University Career Switcher Program, Harvard Midcareer Math and Science Program, Houston Alternative Certification Program, Los Angeles Unified School District Teacher Trainee Program, University of Maryland Alternative Certification Program, Memphis State University Lyndhurst Program, New Jersey Provisional Teacher Program, University of New Mexico/Santa Fe Public Schools Intern Program, Pennsylvania Teacher Intern Program, University of Southern Maine Teachers for Secondary Schools Program, Anne Arundel County (MD) Consortium for Personnel Development, State of Delaware Retraining Programs, Forsyth County (NC) Consortium for Personnel Development, New York City Math/Science Relicensing Program, Long Island University Mathematics Retraining Program, Los Angeles County Teacher Retraining Program, North Carolina Math and Science Education Network, and Virginia Commonwealth University Capitol Region Earth Science Institute.

Table 3

STATUS OF STATES CONCERNING ALTERNATIVES TO TEACHER EDUCATION: 1986

States	Considering Alternatives	Proposed Alternatives	Implementing Alternatives	Not Considering Alternatives	# Certified through 1985-86
Alabama			X		0
Alaska			X		
Arizona			X		20
Arkansas	X				
California			X		320
Colorado			X		-
Connecticut		X			-
Delaware		X			-
Dist. of Col.		X			-
Florida				X	
Georgia			X		0
Hawaii			X		40
Idaho	X				547
Illinois				X	-
Indiana				X	-
Iowa					-
Kansas					-
Kentucky					-
Louisiana			X		-
Maine					-
Maryland				X	
Massachusetts			X		600
Michigan				X	-
Minnesota	X				-
Mississippi				X	47
Missouri					-
Montana			X		-
Nebraska			X		-
Nevada				X	-
New Hampshire			X		249
New Jersey			X		121
New Mexico	X				-
New York				X	-
North Carolina				X	90
North Dakota				X	-
Ohio			X		-
Oklahoma					-
Oregon				X	NA
Pennsylvania					-
Rhode Island				X	-
South Carolina			X		316
South Dakota	X				-
Tennessee	X				200
Texas				X	-
Utah	X				50
Vermont			X		
Virginia			X		
Washington	X				
West Virginia		X			
Wisconsin				X	
Wyoming			X		

From Feistritzer (1986), p. 45.

experience; nonetheless, their graduates were rated reasonably highly by their supervisors on instructional skills. Data on whether these programs would continue to attract sizable numbers of recruits, or whether these recruits would remain in teaching, were not available.

Retraining programs were attended by experienced teachers who wanted greater job security or who were losing enthusiasm for their present area of teaching. These programs involved little classroom supervision for participants' new assignments but instead focused on providing subject matter knowledge. There was some evidence that those who complete retraining programs often do not immediately teach mathematics and science. This may be because current teachers are not very mobile or must wait until vacancies occur in their own district. Adelman expressed concern that there should be more cooperation between retraining programs and local school districts.

Coley and Thorpe (1985a) examined nontraditional teacher education programs at Harvard, the University of Massachusetts at Amherst, the University of Vermont, and Washington University. These four programs were selected to illustrate a sample of nontraditional approaches to recruiting and training individuals with previous mathematics and science preparation and work experience for teaching. All four programs were very small and highly selective in their admissions: The largest of the programs accepted fewer than 30 applicants a year and each program had many more applicants than open positions. The programs typically offered large amounts of student financial support, through scholarships, loans, or paid internships. In addition, the programs tended to be carefully structured to meet the specific needs of nontraditional teacher candidates: They were brief and intensive or were conducted part-time to minimize the time and costs inherent in changing careers while still working full-time. The programs also focused on providing education courses and student teaching experience rather than subject matter coursework, since participants were selected in part because they had a sound knowledge of the subject matter they would teach.

The participants' backgrounds varied widely across the programs, in accordance with the different program goals and recruitment efforts. However, all participants appeared to have reasons very similar to those of traditional teachers for entering teaching: Many were altruistic; many wanted to combine interests in children and science; some were interested in the hours and vacations available to teachers. Participants were attracted to particular programs largely because of their practicality in terms of financial support, cooperation with industry, or flexible schedules. Most of the participants viewed the classroom teaching placement as the most valuable training experience offered by the programs and felt that the training provided by the programs was quite satisfactory, although they expressed concern

about their ability to deal with individual student differences and behavior problems. The proportions of recruits planning to make teaching a career, however, varied substantially across the programs—ranging from 25 to 70 percent.

Fox (1986) described ten nontraditional programs designed to recruit mid-career or retiring scientists and engineers to teaching.[3] She also described six programs that encourage scientists to volunteer in schools and mentioned initiatives of the Department of Defense and National Executive Service Corps to encourage retiring scientists to enter teaching. This report gave only brief descriptions and made few generalizations about the programs described. However, it suggested that schools, schools of education, and employers should encourage scientists to take education courses, engage in practice teaching, or do volunteer work in schools before retirement. The report did not assess whether such expectations might be practical or realistic. Fox also conjectured that some older scientists may have difficulty adapting to a rigid school schedule or maintaining the energy level necessary to cope in a school environment.

RESEARCH QUESTIONS

These earlier program surveys suggest that some programs have been able to attract participants with strong mathematics and science backgrounds, yet the numbers trained in these programs tend to be small, and recruits' plans to remain in teaching may be uncertain. These studies were conducted in a relatively brief time span, shortly after the launching of the new programs. They leave unanswered questions about the programs' longer-range viability and success at tapping pools of nontraditional recruits, and about how environmental differences—certification standards, local labor market conditions, and district personnel practices—may influence program continuation and design. Earlier studies point to the possibilities that selected programs offer for recruiting new entrants, but do not attempt to describe the characteristics of and changes in a larger universe of existing nontraditional programs.

Given the possibility that nontraditional recruits may become an increasingly important source of the supply of mathematics and science teachers, the ongoing experiences of these different types of programs are important to examine. Documenting the range and

---

[3]The ten programs were the George Mason University Switcher Program; George Washington University Career Change Program; Harvard University Mid-Career Math and Science Program; Johns Hopkins University Master of Arts in Teaching Program; University of Bridgeport Project Switch and Teacher Internships; University of Vermont Teacher Preparation Program for Professional Engineers, Scientists, and Mathematicians; University of West Florida Math/Science Initiative; Washington University Post A.B. Teacher Certification Program; West Chester University Industry to Classroom Program; and the State of Delaware Critical Shortages Program.

diversity of these programs will help to characterize the nature of the alternative pools that have been tapped and the circumstances under which initiatives have been sufficiently successful to be sustained by their sponsors.

The survey component of the present national study was conducted during a time of considerable policy activity concerning the requirements for entry into teaching (Darling-Hammond and Berry, 1988) and of rapid change in teacher credentialing requirements across the United States (Hawley, 1986; Southern Regional Education Board, 1986). The survey was aimed at providing the following information for characterizing nationwide efforts at attracting new recruits into mathematics and science teaching:

1. What kinds of preparation are offered by nontraditional programs of different types? How do programs differ in content and requirements?
2. What is the current enrollment of the nontraditional teacher preparation programs?
3. How successful have nontraditional programs been in attracting nontraditional participants such as recent math and science B.A.s, mid-career changers, retirees, current teachers desiring math/science certification, discharged military personnel, or homemakers?
4. What are the economic and opportunity costs to individuals who participate in nontraditional programs?
5. Have there been recent changes in the programs' designs or the target groups they enroll? If so, what sorts of changes have occurred and why?
6. Which types of programs have survived and maintained their enrollments? What are the conditions that appear to threaten or enhance the viability of different program types?

The results of this survey: (a) describe the types of initiatives aimed at new recruits, (b) describe the number and types of individuals recruited to these programs; and (c) discuss the opportunity costs and other characteristics of programs.

SURVEY APPROACH AND METHODS

An immediate challenge to this research was to identify a sample of programs which (a) were partially or wholly aimed at preparing mathematics and science teachers for a credential, and (b) included an emphasis on attracting nontraditional recruits (i.e., not undergraduate education majors).

Consultation with researchers in the field of teacher education indicated that no list of programs meeting our criteria could be developed without resorting to a referral method. Standard sources for identifying teacher training programs were not helpful in identifying such programs because many of these programs are run outside universities, and because university programs are not identified by the target applicant pool. In theory, anyone meeting certain degree requirements can enter a college program. Furthermore, any extant list of teacher training programs concentrating on nontraditional recruits is likely to be outdated quickly, as evidenced by the large number of alternative certification routes that have developed during the 1980s (Darling-Hammond and Berry, 1988; Feistritzer, 1986). Our survey uncovered numerous examples of rapid change in program design and characteristics, as well as several programs that had recently ended. Thus, any list of nontraditional programs and their characteristics is valid only for a brief period of time.

Given the lack of a central list of programs directed toward nontraditional applicant pools, we used a referral method to identify programs. Our preliminary inquiries focused on researchers who had previously identified nontraditional programs, leaders of national teacher organizations such as the National Council of Teachers of Mathematics (NCTM) and National Science Teachers Association (NSTA), and leaders of national associations such as the American Association of Colleges for Teacher Education (AACTE). These informants identified programs that they believed might meet our criteria and directed us to other people who were knowledgeable about such programs.

The list of programs identified by our informants was verified through use of reference materials and, where necessary, telephone calls to program heads. When it was determined that a program was relevant to our study, we asked for basic background data on the programs and asked respondents to identify other teacher training programs that included nontraditional mathematics and science recruits. In total, over 200 such calls were made to informants and program heads—and over 100 potentially relevant programs were identified.

By employing these procedures, we discovered that we had been referred to some programs that were not appropriate for our study. For example, some programs that initially seemed relevant were, in fact, designed to provide training to traditional recruitment pools, to provide enrichment experiences for current mathematics and science teachers, to advertise for prospective teachers from out of state, to ease the transition into teaching for first-year instructors, or to provide guest speakers to mathematics and science classes.

We deleted programs from the sample if they failed to meet any of the following criteria:

a. The program was designed to allow teachers to gain state certification or endorsement. Programs aimed solely at increasing the quality of already-certified mathematics and science instructors, or which did not include any participants seeking certification or endorsement, were thus excluded.
b. The program had the stated goal of attracting nontraditional recruits to teaching. Traditional programs that were not making conscious efforts to attract alternative pools of applicants were thus excluded.
c. The program offered a course of study leading to certification or endorsement specifically in mathematics and science. Programs that aimed at training multiple subject elementary teachers were thus excluded, as were programs directed solely to training teachers for subjects other than mathematics and science.

Over 30 originally identified programs failed to meet these criteria. The resulting list meeting these criteria included 64 programs originating from initiatives of state governments, school districts, institutions of higher education, the federal government, the military, and industry.[4] Specifically, Specifically, three distinct types of programs were included in the final survey:

- *Alternative certification programs* designed to increase the potential supply of teachers by revising certification requirements and providing alternative teacher education programs.
- *Nontraditional recruitment programs* designed to provide potential teachers from nontraditional pools with the coursework and other requirements for full certification. These programs do not require changes in state policies regarding teacher training or licensure.

[4]After completing the telephone survey to identify relevant programs, we sent a brief letter and program description form (see the Appendix) to directors of the programs on our final list (directors of programs included in the second phase of our study were interviewed in person during the second phase, and therefore did not receive copies of the letter and form). The letter asked the program director to review the form and verify the information we had gathered on the program from earlier conversations with the director or program staff. The initial mailing was followed by reminder postcards and phone calls to program directors who failed to return the forms. Through the mailing, follow-up phone calls and the nine on-site case studies, we obtained verification of our data for all 64 of the programs in our sample.

- *Retraining programs* designed to help certified teachers from other fields obtain endorsement or certification in mathematics and science.

In the next section we describe these categories and the programs we surveyed in more detail.

III. A TYPOLOGY OF NONTRADITIONAL RECRUIT PROGRAMS

To understand better the range and characteristics of nontraditional programs, we examined characteristics of program applicants and participants; admission requirements; the type of organization or institution offering the program; the degree or credential obtained by program graduates; the length of time, amount of effort, and cost involved in the program; and the specific coursework and fieldwork content of the program. The remainder of this Note discusses our findings for three sets of programs: alternative certification programs, nontraditional recruitment programs, and retraining programs. Table 4 provides summary information for the three categories of programs. Note that we have separated nontraditional recruitment programs by their primary current mathematics/science recruitment pool: new and recent B.A.s, mid-career changers, or retirees.

ALTERNATIVE CERTIFICATION PROGRAMS

We surveyed a total of ten state alternative certification programs and three sites each within the states of Maryland, Pennsylvania, and Texas (Table 5). These programs provide coursework and field experience required to obtain a teaching credential under state "alternative certification" standards.[1] Our sample includes alternative credentialing programs (ACPs) from the states of California, Florida, Georgia, Louisiana, Maryland, Mississippi, New Jersey, Pennsylvania, South Carolina, and Texas and illustrates a variety of models. Some state programs, like Georgia's and South Carolina's, require that participants be from designated shortage areas, whereas others, like Maryland's, Louisiana's, Mississippi's, and New Jersey's, allow participants from most levels or subject areas. Programs also differ in the degree to which they encourage control from institutions of higher education (IHEs) or school districts. Pennsylvania's program is run primarily through 39 selected college campuses, whereas Florida's, Texas's, and California's programs are more locally administered. For many programs, there are multiple options. In Georgia, for example, one route allows certification through a series of district-based staff development courses that are parallel to standard teacher education courses (except for one course, which is not required); another route requires that students with a B.A. in liberal arts take all of the standard required courses (except one) within three years while teaching on an internship certificate.

[1]Twenty-three states have enacted provisions for alternative certification, most in the last few years (Feistritzer, 1986).

Table 4

SUMMARY OF PROGRAMS IN SURVEY SAMPLE: 1986-87

	Alternative Certification	Nontraditional Recruitment			Retraining Programs
		New B.A.s	Mid-Career	Retirees	
Number Programs in Sample	10	8	16	2	19
Mean Program Length, years	2.1	1.3	1.2	1.3	1.4
Median Program Start Date	1985	1983	1985	1985	1985
Total Number of Participants	863	105	248	55	1172
Mean Number of Participants per Program	107.9	13.1	16.5	27.5	90.2
Percentage Breakdown					
Recent M/S B.A.s	36.1	77.7	12.1	0.0	0.0
Mid-Career	48.7	12.6	58.7	32.7	0.1
Industry Retirees	3.9	2.9	4.5	34.6	0.0
Teachers	6.9	2.9	8.5	0.0	99.8
Military Retirees	2.7	0.0	5.7	32.7	0.0
Homemakers	1.7	3.9	9.3	0.0	0.1
Other	0.0	0.0	1.2	0.0	0.0
Total	100.0	100.0	100.0	100.0	100.0

NOTES: Statistics for alternative certification programs were computed using only state-level program data; data from the nine sites were not used. Programs with missing data were excluded from computations of averages. Programs with no enrollees were excluded from computations of mean program enrollment.

Alternative certification standards generally require fewer hours of formal coursework than regular certification standards but typically require more hours of supervised field experience. This field experience generally takes the form of a teaching internship where the intern is given partial or complete responsibility for a class.

States vary in the amount of formal coursework required before beginning the internship. Some states allow interns to begin their fieldwork and coursework simultaneously; others require a minimum amount of coursework or a workshop before the internship. In nearly all cases, interns receive a salary comparable to that of beginning teachers with full certification. Interns are supervised and evaluated by regular teachers, school principals, or university faculty members. In most cases certification is granted upon completion of coursework and field experience requirements and formal recommendation by supervisors.

Table 5

ALTERNATIVE CERTIFICATION PROGRAMS: 1986–87

Program Name	Start Date	Subject Areas	Program Enrollment (M/S Only) No.	Program Enrollment (M/S Only) Type (%)	Typical Program Calendar Length	Typical Annual Cost	Comments
Florida Alternative Certification Program	1985	All	40	N.A.	1 yr	1600	IHE–based
Georgia Alternative Certification Program	1985	N.A.	N.A.	N.A.	1–3 yrs	Varies by location of course work	New systems will make enrollment information available
California (Los Angeles Unified School District) Teacher Trainee Program	84–85	M/S, English, Social Studies	90	75% Mid-career 5% Teachers 20% Homemakers	2 yrs	None	No costs to participants; state-funded (SB 813)
Louisiana Alternative Certification Program	1978	N.A.	N.A.	N.A.	2-4 yrs	Varies by campus	—
Maryland Alternative Certification Program (ACP) (3 examples follow):	1986	All	180	10% New B.A.s 50% Mid-career 10% Retirees 10% Teachers 5% Military 15% Homemakers	1–2 yrs	Varies by campus: tuition ranges $1700 to $8000	Programs at 6 campuses; M.A. also offered
A. Univ Maryland, Baltimore Post-Baccalaureate Certification Program	9/86	M/S	3	100% Mid-career	1.5 yrs	$1665	Affiliated with Maryland ACP
B. Fort Meade, MD, Alternative Certification Program	9/86	All	20	50% Retirees 50% Mid-career	2 yrs	N.A.	Affiliated with Maryland ACP
C. Maryland Retiree Outreach Program	9/87	All	(0)	100% Retirees	1 yr	Varies by campus	Affiliated with Maryland ACP; began recruitment Fall 1987; Anticipate 6-8 programs
Mississippi Alternative Credentialing Program	1986	N.A.	45	N.A.	3 yrs	Varies by campus	Certificates valid for 1 yr and may be reissued for for 2nd and 3rd yr
New Jersey Provisional Teacher Program	1985	All but spec ed, voc ed, biling./ESL	99	50% New B.A.s 40% Mid-career 10% Homemakers	1 yr	$1350, but varies	—

Table 5—continued

Program Name	Start Date	Subject Areas	Program Enrollment (M/S Only) No.	Program Enrollment (M/S Only) Type (%)	Typical Program Calendar Length	Typical Annual Cost	Comments
Pennsylvania Teacher Intern Program (Programs at 39 campuses) (3 examples follow):	1972	All	234	48% New B.A.s 52% Mid-career	3 yrs	None	Longest-running ACP
A. Temple Univ Intern Program	1972	Math	30	100% M/S majors	2 yrs	N.A.	Affiliated with Pennsylvania ACP
B. West Chester Univ Industry to Classroom	1983	M/S	(0)		1 yr	N.A.	Affiliated with Pennsylvania ACP
C. West Chester Univ Mid-Career Change Program	1983	All	2	40% New B.A.s 25% Mid-career 10% Retirees 10% Teachers 1% Military 14% Homemakers	1 yr	$70 per credit hr	Affiliated with Pennsylvania ACP
South Carolina Critical Needs Certification Program	1985	Shortage areas	125	72% New B.A.s 27% Mid-career 1% Retirees	3 yrs	None	—
Texas Alternative Certification Program (3 examples follow):	1985	M/S and bilingual	50	20% New B.A.s 65% Mid-career 10% Retirees 10% Military 5% Homemakers	15 mos	None or regular tuition	Programs at eight sites
A. Houston Alternative Certification Program	1985	M/S, English, ESL, and bilingual	(0)		1 yr	N.A.	Affiliated with Texas ACP
B. Texas A&M Alternative Cert Program	1985	M/S	8	80% New B.A.s 20% Mid-career	15 mos	$1000	Now affiliated with Texas ACP
C. Texas Tech Accelerated Teaching Program	1986		13	100% Mid-career	6 mos	N.A.	Affiliated with Texas ACP

Alternative certification programs are aimed at individuals interested in teaching, but who are unable or unwilling to devote the time and money to a more traditional program. Participants often begin teaching (and receiving a salary) within several weeks of the start of their program, thus minimizing the amount of time spent without a salary. In addition, state and local education agencies are able to fill teaching vacancies quickly under alternative

certification standards. On the other hand, the teaching interns in these programs generally have less classroom experience and pedagogical training than do graduates of traditional certification programs.

Alternative certification programs require state initiative and typically have state oversight. The actual training takes place at individual universities or school districts, however. Our survey collected information from both the state office overseeing the program as well as from the individual sites where possible. Table 5 reports both statewide data as well as information from the nine individual sites contacted.

Range of Programs

The alternative certification programs included the second largest group of participants in our sample (863). With the exceptions of Louisiana's and Pennsylvania's alternative credentialing programs, all the programs included in this survey began after 1980. In our survey we paid particular attention to evidence of recent changes in the size and other characteristics of alternative credentialing programs. Additional longitudinal research is needed to further investigate the evolution of such programs.

Enrollments in statewide alternative certification programs varied widely—from zero (for sites no longer enrolling mathematics and science participants) to well over 100 in the alternative certification programs surveyed. The Houston program, which was district-initiated and district-run, no longer includes mathematics and science participants, because of a lack of need: Bilingual and elementary teachers are more urgently needed at present.[2] This program, while requiring a change in certification procedures allowed by the state, is one of the few programs initiated by a school district. The programs with the largest mathematics and science enrollments include Maryland's Alternative Certification Program, Pennsylvania's Teacher Intern Program, and South Carolina's Critical Needs Certification Program. Several recent alternative certification programs (e.g., Maryland's Alternative Certification Program, Florida's Alternative Certification Program) noted that enrollments appear to be increasing. The increasing enrollment in alternative certification programs may reflect a general trend toward more interest in teaching as a career (*Education Week*, March 2, 1988).

---

[2]In addition to the contribution of the Houston Alternative Certification Program in 1985-86, Houston hired approximately 230 teachers (including some mathematics and science teachers) that year without the requisite training (*Education Week*, September 25, 1985). The hiring of uncertified teachers in 1985-86 to some extent may have undermined the district's alternative certification program for mathematics and science teachers.

The programs also vary in their primary recruiting pool and success in attracting nontraditional participants, although as a whole, programs are most successful in attracting mid-career changers and new B.A.s. Programs tend to attract a balanced mix of mid-career changers, new B.A.s, and other nontraditional applicants, but some are more narrowly focused. For example, the South Carolina Critical Needs Certification Program and Texas A&M Alternative Certification Programs recruit largely from newly graduated mathematics and science B.A.s, whereas Texas Tech's Accelerated Teaching Program has only mid-career participants. It is striking to note that none of the statewide programs has many retired persons, and only one site (Fort Meade) enrolled a substantial percentage of retirees in 1986-87. Also noteworthy is that no alternative certification programs have large proportions of homemakers training to be mathematics or science teachers.

The alternative certification programs also differ in their typical calendar length. The Texas Tech Accelerated Teaching Program can be completed in just one semester—this program enrolls a high proportion of mid-career changers. At the other end of the continuum are programs such as the Pennsylvania Teacher Intern Program, which requires three years of internship before the participant is eligible for regular certification. The Pennsylvania program tends to enroll half new B.A.s and half mid-career changers. This variation in program length constitutes an important dimension for policy strategists. As a conjecture, programs with shorter calendar length may attract more career changers because of the smaller opportunity costs involved.

It is difficult to draw conclusions about the importance of program costs to the individual, given the amount of missing or ambiguous data we found. It was particularly difficult for respondents to give useful cost data because of the variety of factors relevant to costs (e.g., eligibility for loans, previous coursework, number of elective courses taken, variability of college tuitions among universities within a state). For example, the Maryland Alternative Certification Program has a range of tuitions for participating colleges and universities—from about $1700 to approximately $8000. These findings suggest that one must look at individual training sites and particular participants to determine costs to individuals. The findings also suggest two questions for further research: How do costs to participants affect enrollment, type of recruit, and retention? How do costs to sponsoring agencies affect program continuation and viability?

Illustrations

Two alternative certification programs illustrate the potential contribution to alleviating teacher shortages: the New Jersey Provisional Teacher Program and the California Teacher Trainee Program.[3] These two programs are useful illustrations because they fall near the median of state ACPs in terms of size and start date, yet (a) there is more information available on these programs than those of most other states, and (b) they illustrate two different degrees of dispersal of the alternative credentialing program. New Jersey's program is highly dispersed—it has been used by a large percentage of districts across the state, whereas California's program has been adopted primarily by the Los Angeles School District. Thus, New Jersey illustrates how an ACP works across many different types of settings, whereas Los Angeles illustrates how an ACP can contribute to teacher supply in a large urban district.

The New Jersey program allows districts to employ college graduates who have no education coursework (Schechter, 1987). Participants must have a degree in the subjects they will teach[4] and must pass the state certification test of subject matter knowledge (the National Teacher Examination). They must have an employment offer from a school district that has been approved to provide the necessary supervision and training. New Jersey's Provisional Teacher Program is considered an alternative to emergency certification, which accounted for a majority of new teacher hires during shortages of the 1940s-1960s. The emergency certificate had no requirements at all (Schechter, 1987).

Under the New Jersey program, provisional teachers receive 80 hours of formal instruction during the first six weeks, and for the first month on the job they are supervised by experienced teachers. Provisional teachers then take an additional 120 hours of instruction and are supported by members of a team who observe the teacher and meet to offer feedback. The content of these classes is roughly equivalent to that required of traditional route candidates; since districts add requirements in addition to the 200 units required by the state, candidates using the alternative route usually meet or exceed the 225 units required of traditional teaching candidates. The major difference appears to be the relative emphasis on pedagogical training as opposed to clinical training. The traditional candidate takes more formal non-clinical education coursework. But although a traditional

---

[3]The Los Angeles Unified School District Teacher Trainee Program is by far the largest component of the California Teacher Trainee Program. It accounts for all but a handful of program participants. Table 5 presents data for the Los Angeles district only.

[4]For example, one must have a degree in a physical science to meet requirements for a physical science certificate to teach physics or chemistry. Biological science is considered a distinct area of certification.

candidate usually student teaches for only 80 days, the alternative route candidate must do a full year of full-time teaching. At the end of a year, at the recommendation of a principal, the sucessful alternative route candidate receives a standard certificate.

It appears that the New Jersey program has helped alleviate the state's shortage of mathematics and science teachers. Figures on the percentage of new mathematics and science hires contributed by the program are not readily available, but in September 1985, the program accounted for 11 percent of all new teacher hires, in 1986, 14 percent, and by September 1987, it accounted for 18.2 percent of all new teachers employed by public schools. The program has trained 240 mathematics and science teachers between 1985 and 1988. For all of 1985, the program attracted 42 new science teachers and 44 new mathematics teachers; these were 26 percent and 24 percent of all new provisional hires at that time. In 1986, the program trained 55 new science teachers and 45 new mathematics teachers. Enrollments appear to be stable: In September 1985, 31 science and 29 mathematics candidates entered the program; in September 1986, 36 science and 24 mathematics candidates entered the program; in September 1987, the figures were 33 and 23, respectively.

The New Jersey program has attracted a diverse group of new teachers, many of whom appear committed to teaching. The majority of provisional teachers in New Jersey are over 25 years old, and 20 percent of all provisional teachers are minorities. Large percentages graduated from college with honors. In 1985-86, the attrition rate for the first-year teachers in the provisional program was 10.6 percent compared to 16.6 percent for teachers in the traditional program; in 1986-87, the figures for first year teachers were 8 percent and 15.8 percent, respectively (Schechter, 1987).

The California Teacher Trainee Program is somewhat different from New Jersey's Provisional Teacher Program. Unlike districts under New Jersey's plan, districts in California can participate in the Teacher Trainee Program only if they join the state's mentor teacher program and have determined that fully certified teachers are not available or suitable for departmentalized classes in grades 6-12 (Commission on Teacher Credentialing, 1987). California's plan is similar to New Jersey's in that applicants must pass a basic skills test and a state-adopted test of knowledge, and must have a bachelor's degree with at least a minor in each subject area to be taught. Trainees are exempt from the requirement that they finish a year of postgraduate college study or complete courses in the U. S. Constitution, reading instruction, and health education or special education. During the two years of their trainee status, they must complete a professional development plan (including coursework) developed by the district in consultation with a college.

The California Trainee Program has supplied a substantial number of new mathematics and science teachers. In 1984-85 and 1985-86, the teacher trainee program accounted for 61 (15 percent) of new mathematics teachers, 101 (31 percent) of new biological science teachers, and 24 (24 percent) of all new physical new science teachers in participating districts. Since Los Angeles constitutes the lion's share of the California program, these numbers suggest that district-run alternative certification programs can help supply mathematics and science teachers to urban districts. On the other hand, these numbers also suggest that a majority of new mathematics and science teachers still must be obtained from other sources.

California teacher trainees are a relatively heterogeneous group. More than half of all participating trainees were male (55 percent in 1984-85 and 67 percent in 1985-86). Seventy-eight percent of the 1404 total participants were white, compared to 82 percent for all public school teachers in the state. These figures suggest that minorities participate in this alternative credentialing program at roughly the same rate as for other programs. Across the two school years, almost 40 percent of the participants had not been employed full-time before entering the program.

A small-scale evaluation of the classroom effectiveness of California teacher trainees suggested that program participants were roughly comparable to regularly certified (probationary) new teachers and emergency credentialees. Teacher trainees evaluated their program more positively than did probationary and emergency teachers, possibly because they got more mentor support. However, some teacher trainees did leave the program. Of the 178 teacher trainees who entered the program in Fall 1984, 35 (20 percent) left the program before completing it. Of these dropouts, 78 percent were males. Of the 129 who entered in Fall 1985, 25 (20 percent) left the program within a year.

The experiences of the California Teacher Trainee Program and the New Jersey Provisional Teacher Program suggest that nontrivial—but not overwhelming—numbers of people with majors in mathematics and science teachers can be attracted to teaching by programs that provide (a) nearly immediate employment as a teacher and (b) reduced education coursework.

Changes in Programs

Changes in the Houston School District Program suggest that district-based programs may be more useful for alleviating temporary local shortages than for increasing supply more broadly. Of the alternative certification programs in this survey, Houston's is the only one that no longer includes mathematics and science participants. This program, largely run

by the Houston school district, discontinued mathematics and science training because of a perceived lack of need—bilingual and elementary teachers are more urgently needed at present, and the district alleviated part of its mathematics and science teacher shortage by hiring emergency credentialees. This example suggests that districts that continue to hire emergency credentialees run the risk of undermining their alternative certification programs. This change also shows both the strength and weakness of having school districts control preparation programs. On the one hand, the program was very responsive to the needs of the Houston district. On the other hand, the program did not make a long-term contribution to the number of mathematics and science teachers in the state.

Houston's example also illustrates the ongoing importance of colleges and universities to teacher training, even among alternative certification programs. In Houston's program, there has also been a tendency for local universities to do more of the training than they did in the first year, at least partly because the district did not want to commit large numbers of district personnel to the project. This suggests that institutions of higher education may have indispensable resources even for programs that are largely district-run.

The Texas A&M Alternative Certification Program exemplifies a university program that has adapted and expanded to suit shifting district preferences. At district request, this program has also shifted from an emphasis on career changers to recent graduates. Program officials suggest that one of the reasons for this shift is that districts are reluctant to employ individuals from industry for fear that "they will not adjust to school expectations." Another reason cited was that the pool of mid-career applicants has decreased because of a turnaround in oil industry opportunities—as prospects improved, mid-career applicants became more likely to seek opportunities in the higher-paying industrial sector. Texas A&M's experience suggests that, at the local level, the pool of mid-career applicants will fluctuate considerably depending on economic conditions.

The relative longevity of the Pennsylvania Teacher Intern Program makes it worth noting as a model that may survive while others are changed or discontinued. This program started in 1972 and has survived during a time of relative teacher surplus. Under this program, individuals interested in obtaining a credential through the state's alternative route apply directly to an education school and must have a district willing to hire them as teacher interns. The IHE (Institution of Higher Education) provides required coursework and helps applicants locate a teaching internship. IHEs interested in training teachers under Pennsylvania's alternative certification program must receive state approval for their programs, and the state provides internship certificates based on IHE recommendations. Tuition for IHE-based alternative certification programs is paid by the participants or by the state or district providing the internship. Internships are always salaried, however.

Summary of Findings on Alternative Certification Programs

Our findings on the alternative certification programs suggest the following generalizations:

- Alternative certification programs have attracted nontrivial numbers of nontraditional recruits to mathematics and science teaching, although these numbers are not sufficient to alleviate existing shortages without contributions from other sources.
- Retirees and homemakers remain relatively small pools for alternative certification programs at present.
- Alternative certification programs have been most sucessful in recruiting career changers and new B.A.s.
- Changes in district needs can threaten the long-term viability of locally based alternative certification programs.
- At the local level, the pool of mid-career applicants can fluctuate considerably depending on economic conditions.

NONTRADITIONAL RECRUITMENT PROGRAMS

Overview

The second group of programs are those leading to standard certification. These programs are very similar to traditional IHE-based teacher preparation programs but differ in their target applicant pools. Although traditional teacher education programs typically enroll college undergraduates majoring in education, the nontraditional programs we studied are aimed at noneducation college graduates who are interested in teaching. The programs consist of coursework and field experience required to obtain a teaching credential under regular certification standards. All of these programs are university-based and several lead to a master's degree in addition to contributing to eligibility for certification. Tuition fees are generally the same as for traditional college programs, although many programs offer financial aid which reduces or eliminates the cost to participants.

The nontraditional recruitment programs share several attributes that distinguish them as a group from other program categories. First, these regular certification programs can be implemented without any action of the state legislature or education agencies. Changes in teacher preparation standards are not required and program graduates meet the same requirements as graduates of traditional teaching programs. Second, these programs do not

require special arrangements with local school districts. Field experience arrangements used for traditional teacher training programs such as practicums or student teaching are generally sufficient for programs training nontraditional recruits. Thus, although these recruits are generally older and more experienced than traditional education school teacher trainees, they receive similar field placement experience and training. Finally, nontraditional recruitment programs generally require more coursework and fewer hours of field experience than do alternative certification programs (when on-the-job teaching in the alternative certification programs is compared to the amount of student teaching in nontraditional recruitment programs).

Nontraditional recruitment programs (NRPs) generally involve full-time coursework combined with a field placement. This placement is typically unpaid and does not involve full responsibility for a classroom. Tuition costs are comparable to those of regular college degree programs, and thus nontraditional recruitment programs are more costly to the participant than are alternative certification programs with paid internships. On the other hand, nontraditional recruitment programs that grant concurrent M.A.s allow new teachers to start with higher pay once they begin regular teaching duties.

The average nontraditional recruitment program which focuses on new B.A.s started two years earlier (1983) than did the average alternative certification program (1985). The Washington University Program, begun in 1975, is the oldest program in the entire nontraditional recruitment category. The relative newness of the nontraditional recruitment programs suggests that many early programs designed for nontraditional recruits, like many of the MAT programs begun in the 1960s (Coley and Thorpe, 1985b), have been phased out or have changed focus. Several programs were scheduled to begin or to graduate their first cohort in 1987 during the course of our survey (e.g., the Chevron USA Encore Program and the UC Irvine New Teachers Project).

Also like the alternative certification programs surveyed, nontraditional recruitment programs were most successful in attracting participants from the pools of new B.A.s and mid-career changers.

Range of Programs

In general, enrollments in the nontraditional recruitment programs were similar to those in single-site alternative certification programs but smaller than ACPs that involved multiple sites. The largest nontraditional recruitment programs—the Chevron USA (37) and Michigan State University (50) initiatives[5]—included more than one theme or geographic

[5]The Chevron USA program is an 18 month transition program for former Chevron employees; its special curriculum is designed to provide all requirements for a single subject credential. Michigan State's programs include (a) "Academic Learning" (which emphasizes

location. The Chevron program includes sites at three major Chevron locations: San Francisco, Houston, and New Orleans; the Michigan State initiative consists of four separate programs. Of the single-site programs, UC Irvine, Harvard, Tulane, and Westfield State College had typical enrollments—each had approximately 20 participants.

Many of the nontraditional recruitment programs focused on specific target applicant pools, such as new B.A.s, mid-career changers, or personnel retiring from the military or private industry. However, programs usually enrolled participants from other applicant pools in addition to those from target groups. Indeed, a few programs experienced problems in finding sufficient applicants from their target pools, and consequently modified their recruitment efforts to take advantage of other, more promising pools. In particular, several programs shifted from a focus on retirees toward more emphasis on mid-career changers and new B.A.s. This tendency to adapt recruitment to new pools of applicants is similar to the previously described experience of the Texas A&M Alternative Certification Program, which now attracts larger numbers of recent B.A.s and fewer career-changers (for a fuller description of Texas A&M, see the previous subsection on changes in alternative certification programs). The next three subsections discuss the range of programs for three significant nontraditional recruitment pools: recent mathematics and science B.As, mid-career changers, and retirees.

Recent Mathematics and Science B.A.s

Eight of the nontraditional recruitment programs in our survey enrolled large percentages of recent mathematics and science B.A.s (Arizona State, UC Davis, UC Irvine, University of Massachusetts, University of New Mexico/Santa Fe Public Schools, University of North Carolina, West Chester University, and West Virginia University—see Table 6). Many of these programs are called "fifth-year" programs, since they constitute a fifth year of college following completion of a traditional mathematics or science undergraduate degree. Some participants enter immediately upon completing their regular undergraduate education; others enroll following one or more years of travel or work experience.

Some of the fifth-year programs grant a master's degree in addition to providing eligibility for a teaching credential as a method of attracting new recruits. The University of North Carolina Chapel Hill Lyndhurst Program may be considered typical of such programs.

---

teacher content understanding), (b) "Teaching in Heterogeneous Classrooms" (which emphasizes methods of dealing with individual and cultural differences), (c) "Learning Community" (which emphasizes ways of using cooperative/collaborative activities to foster learning), and (d) "Multiple Perspectives," which emphasizes the role of the teacher as a decisionmaker.

Table 6

NONTRADITIONAL RECRUITMENT PROGRAMS: NEW AND RECENT B.A.S, 1986–87

Program Name	Start Date	Subject Areas	Program Enrollment (M/S Only) No.	Program Enrollment (M/S Only) Type (%)	Typical Program Calendar Length	Typical Annual Cost	Comments
Arizona State Univ Partner Program	1985	M/S	6	100% New B.A.s	2 yrs	In-state tuition	Suspended new recruitment; recently expanded to include other areas
UC Davis MAT Program	1980	Math	7	100% New B.A.s	2 yrs	N.A.	—
UC Irvine New Teachers Project	6/86	M/S	23	62% New B.A.s 30% Mid-career 4% Retirees 4% Homemakers	6 mos or 1 yr	$1942	—
Univ Massachusetts Program MESTEP	1983	M/S, English	19	50% New B.A.s 50% Recent B.A.s	15 mos	$4,800–5,000 for 15 months	Students earn $18,000 to $23,000 during program. New B.A.s have just graduated. Recent B.A.s are within 5 years of graduation
Univ New Mexico/ Santa Fe Public Schools Intern Program	1985	All	4	75% New B.A.s	14 mos	N.A.	Non math/science participants are mostly mid-career changers
Univ North Carolina, Chapel Hill Lyndhurst Program	1982	M/S, English, Social Science	12	100% New B.A.s	1 yr	N.A.	—
West Chester Univ Mid-Career Change Program	1983	All	25	40% New B.A.s 25% Mid-career 10% Retirees 10% Teachers 1% Military 14% Homemakers	1 yr	$70 per credit hr	2 other participants are seeking certification under ACP
West Virginia University Post-BA Program	1973	All	9	Mostly New B.A.s	N.A.	$630 in state; $1670 out of state	Began as an alternative certification route

Started in 1982, this program provides a master of arts in teaching and regular certification to 18 recent college graduates each year, approximately 12 of whom are in mathematics and the sciences. The program requires one year of coursework and field experience and trains teachers in English and social science, as well as mathematics and science. Unlike most fifth-year programs, at the University of North Carolina, the Lyndhurst Foundation provides financial aid to students, including tuition and a stipend.

The University of Massachusetts at Amherst Math English Science Technology Education Program (MESTEP) is also noteworthy, not because it is representative of other programs, but because it is one of the few programs we surveyed that successfully uses industry internships[6] as a way to attract new recruits. It is also the oldest program to use this approach, and it is the model adopted by the Arizona State Partner Program.[7] Since the University of Massachusetts program began in 1983, they have had about 100 applicants each year and have accepted 19-25 students annually. They are resisting expanding their enrollment so that they can remain highly selective, keep a workable cohort size, and ensure that they do not "overproduce" prospective teachers. Like those in many fifth-year programs, participants also receive a master's degree in education and certification in one subject area.

The unique "industry internship" component of the University of Massachusetts initiative involves more complicated program logistics, but businesses and school districts appear pleased with the arrangement. When internships begin in the fall, half of the participants become industry interns and the other half become teaching interns; at the end of the semester, they switch places, so that a pair of interns fill one full-year teaching slot. Half of the participants serve as interns in urban schools, with the rest divided between suburban and rural schools. Districts usually need more graduates than the program can supply, so graduates are highly valued. Interns receive regular salaries from the school or industry during their internships. These salaries typically are $9,000 per semester.

For the most part, the University of Massachusetts program has produced graduates interested in teaching. Participants agree to teach for three years when they enter the program, and in practice, over 80 percent of all graduates have gone into teaching, with 70-75 percent of the total remaining over a three-year period. The program has found that participants are attracted to the program because (1) they can teach quickly, (2) they work in a close-knit cohort, (3) they can remain connected to industry, (4) they can do work that is socially important, and (5) they can earn a salary while in the program. Nevertheless, administrators will be initiating an alumni support network because they have found that graduates often feel lonely and isolated as the only new, young teachers in the schools where they work.

---

[6]Industry internships are an attraction to some new recruits because they allow participants to get experience in education-related work that often pays more than does public school teaching. This work varies depending on the needs of the business, but it can include activities such as collecting data on an industry's training courses, field testing computer training modules, or developing staff training curricula.

[7]For a description of the Arizona State Partner Program, see the subsection "Changes in Nontraditional Recruitment Programs," below.

The University of Massachusetts program has an impact beyond the participants themselves. It has received many inquiries from programs interested in using the industry-to-teaching internship model. The Arizona State Partner program, for example, was modeled after the University of Massachusetts program.

The UC Davis MAT program is noteworthy because of its relatively long length (usually two years), and its unique program of study. The program admits only college graduates who have sufficiently strong mathematics background to pursue graduate-level mathematics coursework. The program requires 36 quarter units of work at the graduate level, including at least 18 units of graduate-level mathematics. Participants must also take 27-36 quarter units of professional preparation courses, take a comprehensive examination in mathematics, and complete an approved discourse (or mini-thesis) dealing with a topic related to mathematics education. Unlike most mathematics courses, the basic graduate-level coursework emphasizes the historical development of mathematics.

The University of Massachusetts and UC Davis programs have focused on training recruits to bring unique skills to the classroom and maintaining selectivity even if this occurs at the expense of program size. The University of Massachusetts program will provide industry-experienced teachers to the schools. Such experience may help the teachers keep up with changing needs for mathematics and science in "the real world," and give teachers a wealth of examples to make their subject matter more interesting. However, exposing students to industry as part of their training also poses some risks. The program may ultimately encourage more students to enter industry than to enter teaching.

The UC Davis example also raises questions. On the positive side, the curriculum focuses heavily on graduate-level mathematics and the historical development of mathematical concepts, providing a unique and useful perspective on the subject matter. Furthermore, the program's rigor and selectivity may enhance the prestige of teacher education across campuses. Nevertheless, the long period of training required and the intellectual difficulty of the required coursework will limit the number of teachers supplied by this initiative.

West Chester University's program is an example of adaptation to new circumstances. In 1983 the university received a three-year grant from the Fund for the Improvement of Postsecondary Education (FIPSE) to retrain people seeking early retirement. In the third year, the name was changed to the "Mid Career Change Program" when it was not possible to recruit enough about-to-retire persons (Fox, 1986). Presently the West Chester University enrolls a plurality of new or recent B.A.s—again, a change of emphasis designed to maintain sufficient enrollment.

The University of New Mexico/Santa Fe Public Schools Intern Program is a model of local-IHE cooperation and changes in primary recruiting pools. In the first year, recruitment was limited to recent graduates of St. John's College, but recruitment efforts have been expanded more broadly in recent years. At present, 17 of the 20 participants are mid-career changers, although three of the four mathematics and science participants are new or recent B.A.s. The program originally had state Title II money but that money has been discontinued. The program's size was increased to increase tuition revenues now that the program depends on tuition. Students attend summer sessions at the University of New Mexico before and after their full academic year teaching internship in the Santa Fe public schools. The 32 hours of education courses have similar content to the regular education coursework but are tailored for program interns. During the first summer, areas covered include learning theory, instructional strategies, and human growth and development (Adelman, 1986).

During the academic year, University of New Mexico/Santa Fe Public School interns participate in weekly evening seminars on instructional strategies and in monthly Saturday workshops on immediate inservice needs. They complete a one-year teaching internship in which they assume full responsibility of regular classroom teachers. Two interns are assigned to each classroom; it is felt that this approach allows for constant feedback and support. During the second summer, secondary interns take coursework in specific methodologies such as reading in the content fields. Elementary interns take classes such as reading, science, or math.

One of the newest nontraditional recruitment programs we surveyed that focuses on new B.A.s is the UC Irvine New Teachers Project (it began in July 1986). This program is similar in size and structure to others in its category but is unique in two respects. First, the program uses currently practicing mentor teachers, rather than college professors, to teach the summer courses in curriculum, teaching methods, and learning theory. It is felt that the currently practicing secondary teachers have a perspective on the classroom that is important to introduce to prospective teachers early in their training. Program directors think the use of an excellent secondary school teacher helps give participants a sense of identity with the teaching profession. Second, the program offers recruits an option of gaining a Preliminary Teaching Credential (usually in six months), or of completing their remaining requirements for the Clear Credential (in 12 months, or with an extra summer of coursework). Program directors feel that the six-month option makes it attractive to some recruits who want abbreviated training.

West Virginia University's Post-B.A. Teacher Certification Program is one of the oldest nontraditional recruitment programs to focus primarily on new B.A.s. The program started as an "alternative" certification route in 1973, when the state allowed substitution of graduate-level courses for the required undergraduate courses.[8] The program is designed for individuals with a strong subject-area background in a teaching field and with strong interest in teaching. Recruitment for the program is basically word-of-mouth—University Arts and Sciences faculty are aware of and supportive of the program and are happy to recommend that their students attend the program if they have an interest in teaching. Most program participants are thus recent West Virginia University graduates, graduate students, or others somehow associated with the university (e.g., lab technicians). The program is also listed as a degree option in university brochures, but word-of-mouth seems to be the predominant means of attracting students. Using only this strategy, the program has had no difficulty attracting qualified candidates. In 1986-87, this program had 59 participants; two were in math, two in general science, three in biology, one in chemistry, one in physics, and the rest in other subject areas. To accommodate both full-time and part-time participants, courses are offered in evenings as well as during the day, and on a full summer schedule. Students must take 27 hours of education coursework, including one semester of student teaching. Master's degree participants take an extra nine credit hours in their content area, for a total of 36 credit hours.

Nontraditional recruitment programs focusing on new B.A.s are usually designed to be small and to fit into an academic calendar. The average enrollment in the eight nontraditional recruitment programs that enrolled predominantly new B.A.s was 13 and the average elapsed time required for completion was 1.3 calendar years. A total of 105 participants were enrolled in primarily new B.A. programs at the time of our survey.

Mid-Career Changers

Sixteen nontraditional recruitment programs in our sample enrolled a plurality of mid-career changers and homemakers (Fairleigh Dickinson; George Mason University; George Washington University; Harvard; Memphis State University; Michigan State; Tulane University; University of Bridgeport, Project Switcher; University of Bridgeport's ongoing program; University of Maryland; University of Southern Maine; University of Tennessee; University of Vermont; Virginia Wesleyan; Washington University; and Westfield State College—See Table 7).

---

[8]The West Virginia University Post-B.A. Program is classified as a nontraditional recruitment program because it meets regular certification standards and has none of the other characteristics we associate with alternative certification programs, such as early assumption of paid teaching duties.

Table 7

NONTRADITIONAL RECRUITMENT PROGRAMS: MID-CAREER CHANGERS, 1986–87

Program Name	Start Date	Subject Areas	Program Enrollment (M/S Only) No.	Program Enrollment (M/S Only) Type (%)	Typical Program Calendar Length	Typical Annual Cost	Comments
Fairleigh Dickinson Univ SCATS Program	6/87	M/S	17	65% Mid-career 35% Retirees	12 mos	None	—
George Mason Univ Career Switcher Program	1986	Science	10	80% Mid-career 20% Retirees	16 wks	N.A.	Provisional certification offered
George Washington University Mid-Career Program	1985	M/S	22	100% Mid-career	2 yrs	$10,800	—
Harvard Mid-Career Math and Science Program	1983	M/S	20	100% Mid-career	9 mos	N.A.	—
Memphis State Univ Lyndhurst Fellowship Program	85–86	Secondary level shortage areas	12	35% New B.A.s 40% Mid-career 5% Military 20% Homemaker	1 yr	None	Affiliated with other Lyndhurst programs
Michigan State Univ Four Alternative Programs	1987	M/S	50	35% New B.A.s 40% Mid-career 5% Military 20% Homemakers	2 yrs	None	Each program has a theme on a specific aspect of teaching
Tulane University Post-B.A. Program	1985	N.A.	20	25% Mid-career 75% Teachers	1.5 yrs	50% reg. tuition; free to teachers	—
Univ Bridgeport, Connecticut Project Switcher	1981	All	(0)	—	1 yr	N.A.	—
Univ Bridgeport, Connecticut	1981	All	15	20% New B.A.s 80% Mid-career	1 yr	N.A.	—
Univ Maryland, College Park Master of Education with Certification	1985	All	8	100% Mid-career	15 mos	$4500	M.A. also offered
Univ Southern Maine Teachers for Secondary Schools	9/83	All	8	100% Mid-career	1 yr	$1737 in state; $5244 out of state	—
Univ Tennessee, Knoxville Lyndhurst Programs	6/85	M/S, English, Social Studies	11	80% Mid-career 20% Military	1 yr	None	—

Table 7—continued

Program Name	Start Date	Subject Areas	Program Enrollment (M/S Only) No.	Program Enrollment (M/S Only) Type (%)	Typical Program Calendar Length	Typical Annual Cost	Comments
Univ Vermont Post-Baccalaureate Teacher Certification Program	1983	All	5	20% New B.A.s 80% Mid-career	1 yr	N.A.	—
Virginia Wesleyan College Alternative Secondary Education Program	1986	M/S, English, Foreign Language	18	39% Mid-career 11% Teachers 50% Military	1 yr	$1960	—
Washington Univ St. Louis, Post-B.A. Teacher Certification Program	1975	M/S, 8 others	12	10% New B.A.s 10% Mid-career 10% Retirees 10% Teachers 35% Homemakers 25% Other	1 yr	$3375	—
Westfield State College Mid-Career Program	1983	M/S, other	20	15% New B.A.s 25% Mid-career 10% Retirees 15% Teachers 30% Homemakers	3 sem	$1375	—

The average enrollment in the 16 mid-career programs was 17 and the average length of time required for completion was 1.2 calendar years. A total of 248 participants were enrolled in these programs. The fact that such a large number of programs enroll a substantial proportion from this group suggests that career changers present an important recruitment opportunity for programs interested in attracting potential mathematics and science teachers.

The Harvard Mid-Career Math and Science Program provides a useful illustration of mid-career programs because it is the best-known and most influential program in this group. In terms of structure and size, the Harvard program is similar to most mid-career programs we surveyed: The Harvard program was started in 1983 and enrolls approximately 20 participants per year. Yet one should not gauge the impact of the Harvard program simply by the number of graduates it produces. This program has received hundreds of letters from individuals and institutions interested in forming their own programs for attracting nontraditional recruits.

Harvard's program is typical in many ways and serves as a model for other programs. Yet Harvard's unique prestige among American colleges may also make the Mid-Career Program somewhat atypical. This prestige allows it to require significant tuition from participants without seriously decreasing its supply of new recruits: over $10,000 for the nine-month program. Financial aid is available but is not automatic nor an integral part of the program. Although applicants must possess a bachelor's degree and a strong background in mathematics or science, the number who apply each year is typically twice the number of positions available. The program includes nine months of coursework and field experience when taken full-time.

The University of Southern Maine has fewer mathematics and science participants (six) than Harvard's, which is a more typical size (20).[9] Yet the University of Southern Maine provides an example of a nontraditional recruitment program that includes all subject areas (including mathematics and science), and is adapting to fit local district needs. This program, which currently enrolls 100 percent mid-career changers, has just expanded to include training for prospective elementary teachers. This decision to add elementary school training parallels that of the Houston School District's alternative certification program, which decided to end mathematics and science training and focus exclusively on elementary training. As with the Houston program, this change came about primarily because of changes in needs. As new needs arise, funding, recruitment, and placement outcomes lead to changes in program focus and design.

Besides Harvard and the University of Southern Maine, 14 other programs enrolled a plurality of mid-career changers. These programs are, with few exceptions, generally similar in size and structure to either Harvard's or the University of Southern Maine's—yet a few have unusual characteristics that should be mentioned. Michigan State's program is noteworthy because it is larger than most, and it contains four special sections with special themes: (a) "Academic Learning (which emphasizes teacher content understanding), (b) "Teaching in Heterogeneous Classrooms" (which emphasizes methods of dealing with individual and cultural differences), (c) "Learning Community" (which emphasizes ways of using cooperative/collaborative activities to foster learning), and (d) "Multiple Perspectives" (which emphasizes the role of the teacher as a decisionmaker).

George Washington University's program was modeled to some extent on Harvard's, but it will be interesting to watch, since it is considering making itself "portable" so that it can be given off-campus at Fort Belvoir, a large local Army base. George Washington's

---

[9]The smaller number for University of Southern Maine reflects mathematics and science participants only—the overall program is roughly the same size as Harvard's.

program, like Harvard's, involves fairly high costs to individual participants. George Mason's program is noteworthy because of its short length (16 weeks) and determination to select only candidates with degrees in physical sciences who have industry experience. The programs at Memphis State and the University of Tennessee have benefited from a long-term relationship with the Lyndhurst foundation—they illustrate the usefulness of stable funding sources. Yet, the University of Bridgeport's program illustrates that loss of funding is not always fatal—"Project Switcher" was absorbed into other university programs when the initial funding source (FIPSE) was discontinued. The University of Maryland's NRP illustrates a program that operates within the same institution as a state-supported ACP. Tulane University's program is noteworthy because it trains both mid-career changers and teachers wishing to switch into mathematics and science teaching; in addition, the program uses a financial incentive (free tuition) to attract more teachers to its program. The University of Southern Maine's program is noteworthy because it was begun as a response to concerns about teacher quality rather than an actual teacher shortage (Adelman, 1986). The University of Tennesee Lyndhurst program was modeled after the University of Southern Maine's (Adelman, 1986). Virginia Wesleyan's program is unique in its current high percentage of military participants and in its first-year success recruiting homemakers to teach mathematics and science. Washington University's and the University of Vermont's programs are useful illustrations of adaptation to new circumstances (see "Changes in Nontraditional Recruitment Programs," below). Westfield State College's program is unusual in the even distribution of types of participants it attracts and its relative longevity. This program is also noteworthy because it has successfully adapted to changes in state regulations governing certification and may soon change as a response to introduction of an apprentice teacher program in Massachusetts.

Retirees

Four nontraditional recruitment programs (Chevron Encore, University of Vermont, University of West Florida, and Washington University, St. Louis) have enrolled at least half of their students as industry or military retirees at one time (Table 8). In addition, Ft. Meade (an alternative certification program) currently enrolls 50 percent retirees. Two of these programs were designed in conjunction with a single specific employer, including a military base (Ft. Meade) and a large industrial firm (Chevron). The others (University of Vermont, Washington University, and University of West Florida) have been university-based.

Although the jury is still out, the experiences of the University of Vermont and Fort Meade programs bring into question how successful programs will be in creating a significant pool of mathematics and science teachers from among retirees. The University

Table 8

NONTRADITIONAL RECRUITMENT PROGRAMS: RETIREES, 1986–87

Program Name	Start Date	Subject Areas	Program Enrollment (M/S Only) No.	Program Enrollment (M/S Only) Type (%)	Typical Program Calendar Length	Typical Annual Cost	Comments
Chevron U.S.A. Encore Program	1/87	M/S	37	50% Retirees 50% Mid-career	18 mos	N.A.	—
*Univ Vermont Teacher Preparation Program for Professional Engineers	1983	M/S	(0)		1 yr	None	Now attracts mostly mid-career applicants (see Table 7)
Univ West Florida Math-Science Teach Ed Program	1983	M/S	15–20	100% Military	1.5 yrs	Between $660 and $825; VA benefits and tuition reimbursement available	—
*Washington Univ St. Louis, Post-B.A. Teacher Certification Program	1975	M/S, 8 others	(0)		1 yr	$3375	Now attracts a mix of applicants (see Table 7)

NOTE: Programs with an asterisk are counted in the mid-career category (see Table 7).

of Vermont program currently enrolls no retirees. The Fort Meade program includes education courses offered on post by local college instructors. Military personnel approaching discharge and others affiliated with the Army can register for these courses. But, significantly, local citizens have been allowed to take courses at Ft. Meade, since the program has not succeeded in filling available spots with military personnel.

Although the Fort Meade example shows that military personnel may be reticent to attend teacher education classes, the director of the University of West Florida program suggests that those who train in such programs may not ultimately enter teaching unless the profession is changed to become more attractive. The University of West Florida program, begun in the fall of 1983, enrolls both Navy and Air Force personnel who want to become mathematics and science teachers upon retirement. The program's director notes that military retirees are in relatively high demand for jobs that pay higher salaries than does teaching.

The Chevron Encore program also merits description—it is the only (currently operating) industry retiree program we surveyed. This program is a cooperative venture between Chevron U.S.A. and three university education schools: San Francisco State

University, the University of Houston, and the University of New Orleans. The program was initiated when Chevron began an early retirement program in response to the mid-1980's oil price collapse. Retiring engineers and other professionals interested in a teaching career are eligible for the program, which consists of an 18-month sequence of courses offered on campus. The participants, universities, and Chevron each contribute toward the cost of the program: Participants are responsible for their own tuition, the universities cover administrative costs, and Chevron pays costs incurred in setting up special classes, bringing in special faculty, etc.

The retiree programs are all relatively new, although others have existed in the past (programs at Washington University and the University of Vermont, for example, focused on retirees at one time, see the discussion below). The State of Maryland has recently initiated a Retiree Outreach Program which will consist of six or seven college-based programs of varying designs. Participants will enroll in special courses at these institutions, and the specific outcome will vary across the institutions.

Changes in Nontraditional Recruitment Programs

Nontraditional recruitment programs focusing on retirees have experienced the greatest changes among all of the programs we examined. As the oldest of the nontraditional recruitment programs, the experience of Washington University Post-B.A. Certification Program may be particularly instructive. Coley and Thorpe (1985a) have described the program and its background. For many years, Washington University had offered a Master of Arts in Teaching (MAT) degree. The Post-B.A. program complemented the MAT program by allowing students to complete credential requirements part-time in the evening division, which required lower tuition than the day program. The program allowed certification in ten subject areas, including mathematics and sciences.

In 1983, Monsanto Corporation's need for engineers was decreasing. It joined forces with Washington University to help alleviate the shortage of high school science and mathematics teachers in the St. Louis area by allowing retiring or near retirement engineers to prepare for a new career in teaching. The program offered several options. Engineers could attend night school or summer classes full- or part-time for a period of one to three years. Participants could receive either a post-B.A. teaching certificate or a Master of Arts in Teaching degree. Monsanto supplied tuition assistance to most program participants. The Post-B.A. program required student teaching and about 24 hours of education courses if all subject matter requirements had already been met (Coley and Thorpe, 1985a).

However, the Monsanto program ended when the company's need to find placements for surplus engineers ended. At the time of the present study, Washington University's Post-B.A. program continues, but it no longer has a focus on retirees. Homemakers now form the largest contingent of prospective teachers in the program, although most of the former homemakers are not preparing to be mathematics and science teachers.

Another program to shift its focus from retirees is the University of Vermont Teacher Preparation Program for Professional Engineers. This program, originally designed for retirees, has now been folded into the University of Vermont's Post-Baccalaureate Teacher Certification Program. The Post-Baccalaureate program trains B.A.s in all fields and, although open to prospective teachers of all ages, currently enrolls no one who is about to retire.

The fact that the Washington University and University of Vermont programs, which focused on retirees, have abandoned the effort suggests that the long-term success of the newer programs in recruiting from this pool is not assured.

Virginia Wesleyan's mid-career program shows how unexpected shifts in the willingness of particular recruitment pools can be accommodated by programs. Virginia Wesleyan targets individuals who already have science, mathematics, foreign language, or English B.A.s but who need education coursework to become certified. The program consists of three college courses, 12 hours of field experience, and student teaching. Students earn 15 hours of undergraduate credit and become eligible for the Virginia Provisional Certificate in Secondary Education.[10] As mentioned above, the Virginia Wesleyan program originally targeted homemakers—enrolling eight in its first year, but this year it has enrolled none. The program now has a majority of career changers, including military personnel interested in preparing for a second career. This experience suggests that mid-career changers may be a more promising pool of propsective mathematics and science recruits than are homemakers.

Changes in the Arizona State University Partner program, which was modelled on the successful University of Massachusetts program, suggest some of the major obstacles to longevity that programs must overcome. This program experienced a large enrollment drop between its first and second years of existence (from 22 in the first year to six in the second

[10]Because the certificate is provisional, other investigators have classified the Virginia Wesleyan program as an alternative certification program. Using our definition, we classify it as a nontraditional recruitment program because the program involved no change in state law, and participants complete all course work before they are allowed to participate in a ten-week preservice teaching experience. This classification is consistent with our treatment of George Mason University's intensive 16-week program, which also results in provisional certification.

year) because of local districts' perceived lack of need for mathematics and science teachers and possibly because of cutbacks in state aid, which increased the cost of attending the program. This program, modeled after the University of Massachusetts' program, demonstrates that changes in financial aid can make a program less attractive to potential participants. It will be interesting to see whether further changes will occur as this program matures. The program has recently expanded to include interns in other curricular areas such as English and foreign language, but they have also decided to have a one-year moratorium on enrolling new interns. These decisions were made for two reasons: First, the program was expanded because of a perceived need in other subject areas. Second, the moratorium was called because of districts' hestitancy to make a three-year commitment to program interns. The program will consider how to deal with this problem in the next year.

The lesson of the Arizona State example is that nontraditional recruitment programs, like alternative credentialing programs, require that districts make a commitment to training and supervision. Without obvious benefits to the district (e.g., funding or ability to meet acute staffing needs), the programs cannot be a stable source of recruits.

Changes in nontraditional recruitment programs suggest that even when specific programs are ended, ongoing programs may derive residual benefit from increased nontraditional enrollment. For example, the University of Bridgeport's Project Switcher Program ended, at least in name, when funding ran out. Nevertheless, the University of Bridgeport continues to attract a substantial proportion of mid-career participants to its ongoing teacher internship program.

The program changes at Washington University and the University of Vermont—shifting from a focus on retirees to other applicant pools—suggest that existing teacher education programs may do the same job as alternative certification routes if they expand their "marketing" to attract a wider range of applicants. These programs adapted their recruitment strategies to attract new recruitment pools when former sources declined.

Summary of Findings on Nontraditional Recruitment Programs

Our findings on the nontraditional recruitment programs suggest the following generalizations:

- Individual nontraditional recruitment programs have for the most part remained small, in some cases because institutions of higher education have valued maintaining entry qualifications.

- Nontraditional recruitment programs have been most successful in recruiting new B.A.s and career changers.
- Retirees and homemakers remain relatively small pools for nontraditional recruitment programs.
- Some nontraditional recruitment programs have an influence beyond the number of teachers they produce. They serve as models for other institutions' programs.
- Nontraditional recruitment initiatives show a tendency to lose their identity with particular recruitment pools as these programs respond to changes in applicant availability and district needs.
- Changes in district needs and program funding levels can threaten the long-term viability of nontraditional recruitment programs.
- Programs supported by single employers are influenced by changes in employers' needs for skilled personnel and hence are unlikely to provide significant long-term sources of mathematics and science teachers.

RETRAINING PROGRAMS

Overview

The final group of programs studied were retraining programs (Table 9). These programs are aimed at current teachers in nonshortage fields, providing them with the subject matter coursework required to obtain certification in mathematics or science. Most of these programs are part-time or summer workshops, although the largest group we surveyed—the Hellman Academy programs—are one-year, full-time programs. Some of the part-time programs require up to three years to complete; these programs involve evening and weekend classes in mathematics or science which are taken by full-time teachers. Most programs are tuition-free, but the time commitment is significant when viewed as an addition to full-time employment.

Retraining programs generally have more participants per site than do either the alternative credentialing or nontraditional recruitment program sites. Because these programs tend not to require or provide supervised internships, and they feature large lecture instruction, there are some economies of scale at each site, permitting larger numbers of participants. The large number of participants per site in retraining programs suggests that retraining programs may attract a larger number of potential mathematics and teachers than do alternative credentialing or nontraditional recruitment programs—or that retraining programs have not been as selective in their recruitment as have the nontraditional

Table 9

RETRAINING PROGRAMS: 1986-87

Program Name	Start Date	Subject Areas	Program Enrollment (M/S Only) No.	Program Enrollment (M/S Only) Type (%)	Typical Program Calendar Length	Typical Annual Cost	Comments
Anne Arundel County, MD, Science Retraining Program	1984	Science	40	100% Teachers	3 yrs	N.A.	—
Arizona State Hellman Academy	1985	Math	(0)	—	15 mos	$200	Retraining continues in traditional programs. Hellman program increased district awareness
Beaver College Hellman Academy	1985	Math	47	100% Teachers	Varies	N.A.	Revised Hellman program now funded by Title II and districts
Delaware Retraining Program	1985	M/S, Computers	100	100% Teachers	1 yr	None	—
Kentucky Summer M/S Retraining Program	1986	Math, Physics	70	100% Teachers	15 mos	$1000	—
Long Island Univ Hellman Academy	1976	M/S	25	100% Teachers	Varies	Varies	Title II picked up funding once FIPSE funding ended
Los Angeles County M/S Teacher Retraining Program	82-83	M/S	131	100% Teachers	2.5 yrs	None	Program suspended after 1987 because of cut in state funding
New York City Math/Science Relicensing Program	1982	M/S	23	100% Teachers	1 yr	N.A.	—
North Carolina Math and Science Education Network	1984	M/S	420	100% Teachers	1 yr	N.A.	Enrollment based on program director's estimate that 10% of enrollment includes participants being certified in M/S for 1st time from non M/S fields
Portland Public Schools Hellman Academy	1985	Math	(0)	—	2 yrs	$650	Was financially supported by district
Temple Univ Part-Time Certification Program	N.A.	Math	120	100% Teachers	N.A.	N.A.	—
Texas Woman's Univ Hellman Academy	1985	Math	(0)	—	15 mos	N.A.	Similar programs continue in absence of Hellman funds

Table 9—continued

Program Name	Start Date	Subject Areas	Program Enrollment (M/S Only) No.	Program Enrollment (M/S Only) Type (%)	Typical Program Calendar Length	Typical Annual Cost	Comments
Trenton State College Hellman Academy	1985	Math	60	100% Teachers	19 mos	None	Title II picked up funding. Program to become self-supporting
Univ Miami Hellman Academy	1985	Math	(0)	—	1 yr	$2000	Now involved in FAME program for elementary teachers
Univ N. Colorado Hellman Academy	85–86	Physics	(0)	—	15 mos	$400	Institutionalized Hellman model in M.A. program
Univ Santa Clara	1982-83	All	(0)	—	N.A.	N.A.	Retraining programs supported by Chevron and Packard Foundations ended in June 1985 and June 1986
Virginia Commonwealth Capital Region Earth Science Institute	1985	Earth and Space Science	60	100% Teachers	1 yr	N.A.	—
Western Oregon State College Hellman Academy	1982 (1985)	Math	30	5% Mid-career 90% Teachers 5% Homemakers	2 summers	$250–400	Joined Hellman program in 1985. Now has self-sustaining program
Winston-Salem/ Forsyth County, NC, Consortium for Personnel Development	1981	All	46	N.A.	1 yr	N.A.	—

recruitment and alternative credentialing programs. The largest retraining programs include the North Carolina Math and Science Education Network, the Delaware program, Temple University program, and Los Angeles County program. It is not surprising that the North Carolina and Delaware programs are large, since they involve multiple sites across their respective states.[11] The Temple University program is one of the largest single-site nontraditional programs surveyed: It includes 120 participants.

[11]The enrollment figures for the North Carolina program are estimates obtained from the program administrative staff.

The extended calendar lengths for some retraining programs are a reflection that it takes time to become proficient in a new subject area, and a reflection that teachers usually attend these programs part-time, often on top of their full-time teaching duties. The retraining programs' calendar lengths ranged from one to three years.

It is striking that most retraining programs are free to teachers, and are usually paid for by the school district that employs the participant. These programs serve a direct purpose for school districts by filling their staffing needs with people it has already hired. From the district viewpoint, these teachers have a track record and may be considered better bets for commitment to teaching and "fitting in."

District assumption of costs may encourage teachers to enroll in retraining, but it may also contribute to the large attrition rate sometimes found from such programs (Adelman, 1986). For example, Adelman (1986) found attrition rates as high as 33 percent and 60 percent among the eight retraining programs she studied.

All of the retraining programs we surveyed were started in the 1980s with the exeption of the Long Island University Hellman Academy Program. The relative newness of these retraining programs suggests that, like nontraditional recruitment programs, retraining programs may not last as distinct entities after the initial concern about a teacher shortage has dissipated.

Unlike the alternative credentialing programs and nontraditional recruitment programs we studied—which often focused on a variety of subject matters—retraining programs usually focus exclusively on mathematics or science training. This finding has relevance to the types of initiatives one might sponsor. Although retraining programs might be appropriate for subject-specific shortages, a general teacher shortage may be better addressed by more broad-based recruitment efforts.

Illustrations

The oldest retraining initiative is the Long Island University Hellman[12] program, which began as a response to the problem of teacher layoffs in most educational areas and severe shortages of mathematics and physical science teachers. At that time, it consisted of a one-year full-time course of mathematics study. The National Science Foundation supported the program from 1977-1981, and Long Island University supported the program

[12] The program is named in honor of the project's original director, the late Dr. Morton J. Hellman, Chairman of the Mathematics Department at the Long Island University Brooklyn campus from 1966-1979. Hellman programs are called by the acronym THA-MASTER, which stands for "The Hellman Academy for Mathematics and Science Teacher Education Retraining." The program head from 1979-1986 was Madeleine J. Long.

with interim funds in 1982-1983. The Fund for the Improvement of Postsecondary Education (FIPSE) supported the program from 1983-1986; these funds allowed the program to be disseminated to other sites. The program also received some funding from Title II through the New York State Education Department. Under the NSF grant, participants did not pay tuition for the program, and tuition was reduced under LIU and FIPSE funding. For the most part, teachers in a given cohort take their classes together. The fact that teachers stay together to support one another is considered an important feature that contributes to teachers' morale and learning.

LIU's Hellman mathematics curriculum was a structured sequence of courses that began with a review of basic algebra skills and extends through calculus and other topics. Students graduating from the Long Island University Hellman program scored higher on New York City tests of mathematics proficiency than did mathematics majors—possibly because the content of the Hellman program was more directly related to high school mathematics curricula than is a college mathematics curriculum.[13]

The success of the Long Island University Hellman mathematics program encouraged it to disseminate its program to other sites and develop a program for training teachers in physics—FIPSE funding supported these efforts. LIU received 150 applications from other institutions interested in implementing and adapting the Hellman model. In 1984, the original Long Island University site added a program to prepare teachers to teach physics by taking six three-credit classes in topics such as mechanics, energy, and electromagnetism. A new site at University of Northern Colorado also had a course sequence that allowed teachers (usually in other sciences such as biology) to retrain to teach physics. Western Oregon State College had a self-sustaining teacher retraining program, which was aided by affiliation with the Hellman program. Western Oregon State adopted the Hellman model for its Monmouth campus and adapted the Hellman model to centers in Salem and Central Oregon by using videotapes, combined with workshops, to train prospective mathematics teachers in calculus. It was thought that the videotape method could serve as a model for areas wanting to train mathematics teachers in widely dispersed rural areas. Only a handful (three to four) of the 30 teachers per year completed the videotape/workshop programs at the Salem and Central Oregon centers, for two reasons. First, the state of Oregon dropped the calculus requirement from the states' lower-level mathematics certificate. Second, students found it very difficult to learn calculus without more help from an actual instructor. Western Oregon State continues to have a self-sustaining (nonvideotape) teacher retraining program. The Hellman program was also disseminated to the Portland (Maine) Public Schools, which financially supported the program without benefit of Hellman funds.

---

[13]Personal communication from former program head Madeleine J. Long, March 3, 1988.

In 1986, FIPSE funding ended, although a no-cost extension was obtained for a conference that took place in 1987. However, many of the Hellman sites continue to be active in training teachers in mathematics and science. At Long Island University, the Scientific Specialization for Exemplary Teachers Program (SSET) has trained elementary teachers in mathematics and science to become "lead teachers" in their schools and districts. Currently at Long Island University, the Fellows for the Advancement of Mathematics Education (FAME) program is dedicated to training mathematics and science teachers for elementary schools. This program, supported by a major grant from NSF (and minor support from LIU and school districts), trains elementary teachers in mathematics and science who will eventually become "lead teachers" at their schools. The FAME program includes a student volunteer component that encourages mathematically able minority students to tutor others, in the hope that these students may decide to try teaching. Under FAME, there are also programs to encourage teachers to do their own "action research" on curriculum and instruction, and a program that trains parents in mathematics and science teaching.

Many other former Hellman sites continue to train mathematics and science teachers. The FAME program will be disseminated to Texas Woman's University and University of Miami. Trenton State College is taking part in the SSET program, which trains teachers for one year in mathematics or science and for one year in curriculum development and instructional leadership—19 teachers are currently involved in that program. Trenton State has continued its Hellman program through December 1988 using Title II money. After December 1988, Trenton State intends to institutionalize the Hellman model by making the program self-sustaining through support from tuition revenues. Districts are likely to pay for teachers' retraining in many instances. The program is in such great demand from districts and individuals—they have had to turn away many qualified, interested teachers—that Trenton State anticipates that enrollment will not decrease once Title II support ends. In another continued program, Beaver College has successfully found Title II money to continue its mathematics science retraining program (current enrollment 47) with some modifications from the original Hellman design. The University of Northern Colorado has institutionalized its Hellman design into an M.A. program for retraining science teachers to teach physics. Western Oregon State College's program has also continued without its previous affiliation to Hellman: It presently has a self-sustaining program for retraining teachers to be mathematics teachers.

Los Angeles County is another, quite different example of a retraining program. Unlike the Hellman Academy, which primarily received federal grants, this initiative was state funded. It consists of multiple sites, each administered by a separate university or college.

In at least one instance, the decentralized nature of the LA County program fostered innovative approaches to retraining. Particularly innovative was the approach taken by California State University at Long Beach (CSULB), whose "Project Retrain" focused on preparing teachers to be instructors of junior high school science. This program's curriculum was "modular," with each module addressing a specific set of junior high school science topics such as "light," "sound," or "structure of matter." Each module had been designed jointly by a CSULB professor and an experienced precollege "master" teacher. The idea had been to blend the professor's deep knowledge of the subject matter with the master teacher's understanding of how students learn and understand. Modules were taught by teacher-professor teams, emphasizing "hands-on" learning to focus on teachers' understanding of the concepts while simultaneously modeling ways to help students learn that content.

The modular approach taken by CSULB appears to have worked well. Modules were designed to be shorter than typical college courses and they followed more closely the typical junior high school science curriculum. Furthermore, the shorter time between modules allowed teachers to assimilate the material in smaller bites—thus decreasing anxiety dramatically.

The New York City Board of Education Mathematics and Science Relicensing Program is another model for retraining programs (Cooper, 1987). It is of particular interest because of its sustained involvement with urban schools. In this program, New York City schools sponsored mathematics and science classes taught by professors at nearby universities for teachers who wanted to retrain from fields such as English and history. The courses were held after hours and during the summer, were available only to New York City teachers, and were free to participants (including books and materials). The credits required for certification in the disciplines were 18 for junior high mathematics, 24 for senior high mathematics, and 36 units for senior high biology, chemistry, physics, or general science certification. After the courses were passed, candidates were required to pass a citywide examination. Next, participants had to take a probationary position in the new field for two years—after two years, these veteran teachers came up for tenure in the new subject.

A diverse set of classes was offered by the 11 universities and colleges participating in the New York program (Cooper, 1987). Science classes included genetics, gross anatomy, ecology, physics, chemistry, and biological conservation. Mathematics classes included college algebra, number systems, analytic geometry, and basic and advanced calculus. A school district by itself would not be able to offer such a wide range of courses without the participation of colleges and universities.

In 1985-86, the New York City Board of Education evaluated the relicensing program (Cooper, 1987). Of the 626 teachers who participated in the program, 61 percent were women and 45 percent were black or Hispanic. These figures show that the program has the potential to create role models for underepresented groups, since only 17 percent of all high school teachers and 28 percent of junior high teachers in New York City were members of minority groups.

The attrition rate from the program, however, was high. One-third of the mathematics participants did not finish their first mathematics course, and half of the science participants did not finish their first science course (Cooper, 1987). Furthermore, only 32 percent of those who completed the course requirements for the program passed the required citywide examination. In all, 88 teachers met all requirements in mathematics and became eligible to teach mathematics in New York City classrooms in 1985-86. Although the New York City experience shows that it is possible to attract large numbers of teachers interested in switching to teach mathematics or science, the high attrition rate raises questions about the efficiency of this retraining model for dealing with subject-specific shortages.

So far we have described the Long Island University Hellman Program, the Los Angeles County Retraining Program, and the New York City Retraining Program. Of the remaining 16 retraining programs we surveyed, eight were Hellman programs similar in structure to the Long Island model (Arizona State, Beaver College, Portland Public Schools, Texas Woman's University, Trenton State College, University of Miami, University of Northern Colorado, and Western Oregon State College).[14]

The eight programs we have not described in detail[15] represent an array of models for retraining programs. Of the eight non-Hellman programs, the Anne Arundel County,

---

[14]For a fuller description of these programs, see "Changes in Retraining Programs," below.

[15]These were the Anne Arundel County Science Retraining Program; Delaware Retraining Program; Kentucky Summer Mathematics/Science Retraining Program; Temple University Part-Time Certification Program; Virginia Commonwealth Capital Region Earth Science Institute; Winston-Salem/Forsyth County Consortium for Personnel Development; North Carolina Math and Science Education Network; and University of Santa Clara.

and Winston-Salem/Forsyth County programs represent locally based approaches to retraining. The Anne Arundel County program takes the longest average time to complete of any retraining initiatives we surveyed (three years), but teachers participate part-time. The Anne Arundel County Public School system funds and implements this county-sponsored program to retrain and upgrade science teachers; the University of Maryland provides the coursework (Adelman, 1986). Tuition and laboratory costs are provided by the public school system, and participants must agree to teach in the county for a year following program completion (Adelman, 1986). The Winston-Salem/Forsyth County Consortium for Personnel Development consists of Salem College, Wake Forest University, Winston-Salem State University, and the North Carolina Department of Public Instruction. These institutions can prepare teachers in nine certification areas including mathematics or science education (grades 6-9 and 10-12). This program is unusual in that participants are responsible for their own tuition costs.

The Kentucky Summer Mathematics/Science Retraining Program; Delaware Retraining Program; Virginia Commonwealth Capital Region Earth Science Institute; and the North Carolina Teacher Recertification Program represent state-based approaches to retraining. The Delaware program includes retraining teachers and teachers upgrading from junior high mathematics and science certification to secondary certification. The program is state-funded; teachers take classes tuition-free and receive a small stipend for the summer portion of the program. Delaware's programs are unusual in that they were developed to prevent projected shortages of mathematics and science teachers (Adelman, 1986); like many programs, it is state-funded and teachers take classes tuition-free and receive a small stipend for the summer portion of the program. Unlike most retraining programs which are free to participants, the Kentucky Summer Mathematics/Science Retraining Program typically costs participants $1,000, although local school districts often pay these costs. The Capital Region Earth Science Institute of Virginia Commonwealth University is unique in that it focuses specifically on certification in earth and space science. Teachers who are not already certified in science must take 24 hours of earth and space science; included in the 24 units must be at least one course of biology, chemistry, physics, or mathematics. Teachers who are already certified in science are required to take 18 hours of earth and space science (Adelman, 1986).

Changes in Retraining Programs

Changes in retraining programs come about for two distinct reasons: (1) budgetary difficulties and (2) problems with district cooperation. Some programs have survived these obstacles and others have undergone significant changes or have terminated.

One program that has experienced funding difficulties is the LA County Program. This program was eliminated in the 1987-88 California budget. The budget cut was related to state political conditions rather than to the effectiveness of the program, and funding might be restored in the future.

The Arizona State Hellman Program also ended when the FIPSE funding was ended, although Arizona State continues to retrain teachers in mathematics through its traditional programs. The Arizona State program went through just one cycle. During that cycle the program began with 32 participants and ended with 19, representing 41 percent attrition. The Hellman program currently has no participants because the funding cycle was completed and no new funding was sought. No new funding was sought in part because the program head feels that teachers have more commitment to learning mathematics if they must pay their own expenses. Despite the demise of the program, the program director credits Hellman with giving new life to ongoing mathematics education at Arizona State. In particular, school districts around Arizona State became more aware of the potential source of new mathematics teachers within the ranks of nonmathematics teachers; second, districts learned that university training is desirable for teachers who wish to retrain. Although it is difficult to pinpoint the Hellman program as the sole reason that enrollment has increased in the Arizona State mathematics program, the Hellman program undoubtedly contributed.[16] This example, like several of the nontraditional recruitment programs described above, suggests that programs need not survive in name to have an ongoing influence on the production of teachers at particular institutions.

The Texas Woman's University's (TWU) Hellman Program no longer exists now that the funding cycle has been completed, but similar programs are continuing at TWU using funds from state and institutional sources. For example, its Elementary/Secondary program started in spring 1986 with 40 students, 20 of whom were applying for elementary certification (in mathematics) and 20 for secondary certification. One district has provided its teachers with extra tutoring, which has been considered important in keeping some students in the newer program. As opposed to newer TWU retraining programs, a unique

[16]As noted above, the increasing enrollment in alternative programs may also reflect a general trend toward more interest in teaching as a career (*Education Week*, March 2, 1988).

aspect of the Hellman program was that the cohort started and ended at the same time; the current ongoing retraining programs accept participants at many times of the year, so cohorts do not stay intact. The University of Miami Hellman Program no longer has participants, but the program director notes that the local school system "now has a program to accomplish these objectives" (at no cost to participants).

The University of Northern Colorado Hellman Program ended once the funding cycle ran out, so the program has now been assimilated into the M.A. teacher education program at UNC. This program was never directed toward certification for nonscience teachers, but has always been directed toward upgrading the physics knowledge and understanding of currently certified science teachers. For example, the UNC program might retrain a biology teacher to teach physics, but it would not attempt to train an English teacher to teach physics.

Despite the loss of Hellman FIPSE funding, the Beaver College program has substantially expanded and revised the original Hellman program using State of Pennsylvania Title II funds. The college received approximately $288,000 for retraining and upgrading in 1986-87 and 1987-88 from Title II, and another $150,000 in contracts from state and district sources. The program is currently retraining 22 teachers in mathematics and 25 in chemistry.

The college has added courses, redesigned courses, and added a very popular colloquium series funded by the college and local districts. They now teach a content course concurrently with a teaching methods course that stresses content knowledge. For example, participants take a class in probability and statistics from a college professor concurrently with a class in methods of teaching probability and statistics taught by an exemplary high school instructor. The professor and high school teacher are in constant communication, often sitting in on each other's classes. The colloquium series is another new feature of the Beaver College program. In 1987-88, it includes topics such as concepts of probability, concrete strategies for teaching algebra, and methods of problem solving. So far each of the colloquia have been attended by over 100 teachers from local districts. Beaver College credits its strong relationship with local districts for encouraging its programs to continue to expand when FIPSE funding ended.

The Trenton State College Hellman program, currently on its third cycle, has continued in a mold very similar to the original Hellman Program, despite the loss of its original funding. Trenton State has continued its Hellman program through December 1988 using Title II money. After December 1988, Trenton State intends to institutionalize the Hellman model by making the program self-sustaining through support from tuition revenues. Districts are likely to pay for teachers' retraining in many instances. The program is in great demand from districts and individuals—they have had to turn away many qualified,

interested teachers. Trenton State anticipates that enrollment will not decrease once Title II support ends.

It is not clear why some of the original Hellman programs have continued under new funding while others were allowed to end. However, each of the survivors have remained viable by using other funding sources than the original grant that created them. Beaver College continued by virtue of Title II money and contracts with Philadelphia and the State of Pennsylvania; Long Island University continued by using an NSF grant, but its efforts have been redirected toward training elementary school teachers in science and mathematics; Texas Woman's University has continued retraining participants to become secondary school mathematics teachers through grants from the state of Texas; Trenton State's program has so far continued with the help of Title II money, and Western Oregon State's program became self-sustaining through tuition revenues.

Summary of Findings on Retraining Programs

Our findings on retraining programs suggest the following generalizations:

- Most retraining programs feature free or nearly free tuition for teachers who want to enter the fields of mathematics and science.
- Retraining programs generally have more initial participants per site than do alternative certification or nontraditional recruitment programs.
- Retraining programs tend to suffer from high attrition.
- Retraining programs usually focus exclusively on mathematics and science training. Although retraining programs might be appropriate for subject-specific shortages, a general teacher shortage might be better addressed by more broad-based recruitment efforts.
- Changes in district needs and program funding levels can threaten the long-term viability of retraining programs.
- Programs that lose federal funding can sometimes maintain viability by tapping state and local funds, or by relying on tuition revenues.
- Many programs are expanding or replacing earlier programs to include training for elementary mathematics and science teachers.

IV. SUMMARY AND CONCLUSIONS

Our research describes nontraditional programs in terms of the kinds of preparation they offer, their current enrollments, their success in attracting nontraditional recruits, their costs, and their recent changes. In the course of surveying programs, we learned some things that shed light on the assumptions underlying the use of nontraditional programs as a policy strategy: (1) that productive pools of recruits can be identified, (2) that programs can be devised to meet special needs, and (3) that programs can be sustained long enough and can produce enough teachers to make a significant difference in the supply of recruits to mathematics and science teaching. These findings lead to conclusions and speculations concerning two questions: What factors contribute to a program's longevity? And what are the most promising policy options for alleviating the mathematics and science teacher shortage?

TYPES OF PREPARATION PROGRAMS

In attempting to organize and compare the programs we surveyed, we were struck by the diversity of program attributes. Although all programs share an ultimate objective of recruitment and preparation of mathematics or science teachers (and, in most cases, teachers in other fields), they vary widely in their approach to this goal. In particular, programs differ in the recruitment pools they are designed to tap and the content of their training.

Recruitment Pools

To be included in our study, programs had to meet one or both of the following criteria: (a) a focus on nontraditional recruits into teaching, or (b) the use of nontraditional training or certification procedures. "Nontraditional recruits" consist of several classes of individuals who differ from traditional undergraduate education majors: (a) newly graduated mathematics or science majors with an interest in teaching; (b) relatively recent mathematics or science college graduates whose postcollege jobs proved to be unsuitable to their interests or who traveled, volunteered, or were unemployed following graduation; (c) older college graduates who have been out of the labor force, temporarily unemployed, or have decided to change careers; and (d) adults who are retiring from the military or other government or private sector employers.

A program's recruitment pool constitutes an important dimension for two reasons. First, the size of each pool varies considerably across states and across time, thereby affecting a program's ability to meet its enrollment goals. Second, the design of a program is also closely tied to its applicant pool. Programs aimed at mathematics and science majors consist of teaching methods courses and internships; retraining programs designed for current teachers in other fields consist almost exclusively of math or science coursework. More subtle differences are seen in new-B.A. versus mid-career and retiree programs: programs aimed at new B.A.s are likely to mirror regular college courses; programs aimed at the latter recruit pools generally have been modified to fit better the experiences and schedules of mid-career and retiree participants.

Program Content

The specific content of the programs varied considerably as well. Alternative certification programs provide pedagogical coursework and field experience required to obtain a teaching credential under state "alternative certification" standards. Participants are usually able to assume (and be paid for) full teaching responsibilities quite quickly in these programs. As a result, alternative certification standards generally require fewer hours of formal coursework than required under regular certification standards but typically require more hours of supervised field experience. Required coursework focuses more on education and pedagogy than on subject matter, since participants are generally screened for their subject matter background before entering the program.

Nontraditional recruitment programs prepare candidates for standard certification; they tend to include more content area courses but supplement them with coursework in teaching methods. These programs also include a field placement. In most cases this placement involves student teaching and observation rather than complete responsibility for a class.

As mentioned above, retraining programs aimed at current teachers consisted primarily of mathematics or science coursework. Retrainees already have significant field experience and teaching knowledge but lack the content area knowledge required to obtain certification and teach in mathematics or science. Retraining programs often provide this knowledge through standard college-level math or science courses, although some retraining programs offer separate classes designed specifically for retrainees.

CURRENT ENROLLMENTS IN NONTRADITIONAL PROGRAMS

Many of the nontraditional programs we studied are comparatively small at present. Although smallness has helped some programs remain selective, it raises the question of how large an impact they will have on aggregate numbers of new mathematics and science teachers. Our survey uncovered 64 programs that trained well over 2,000 mathematics and science teachers during the 1986-87 school year—a small but nontrivial proportion of the approximately 20,000 new mathematics and science teachers needed each year.[1] Of course, these programs also have significant influence on certain local or statewide shortages; 18 percent of all New Jersey teachers come from the Provisional Teacher Program, and the California Teacher Trainee Program supplied 15-30 percent of new mathematics and science teacher hires in its participating districts (Commission on Teacher Credentialing, 1987)—including Los Angeles, which has had difficulty attracting sufficient numbers of new teachers in the past.

Although the numbers appear nontrivial compared to the aggregate number of new teachers needed, it is also clear that the new programs do not, by themselves, attract enough participants to solve the shortage of qualified mathematics and science teachers. Furthermore, the rate at which programs are created, modified, and ended raises questions about how permanent the gains are from the creation of these programs.

SUCCESS IN ATTRACTING NONTRADITIONAL PARTICIPANTS

Retirees appear to be a relatively small source of mathematics and science teachers, given the evidence presented here. We suspect that members of this pool may be unable or unwilling to enter mathematics and science teaching in large numbers. Of course, dramatic changes in program design, and the working conditions of teaching or financial status of retirees, may alter this conclusion.

---

[1]We derive our estimate of a nationwide demand for over 20,000 new mathematics and science teachers per year in the following manner. The Center for Education Statistics (1987) estimates that there were 972,398 seondary school teachers in 1986-87. The NEA (1987) estimates that in 1986, 19.2 percent of all secondary instructors primarily taught mathematics and 11 percent taught science—which suggests a total of over 290,000 secondary instructors in these subjects. Grissmer and Kirby (1987) predict that future attrition of mathematics and science teachers—the largest single component of demand—will be considerably higher than the Center for Education Statistics' current prediction of 6 percent for teachers from all subjects and grade levels. Grissmer and Kirby found that mathematics and science teachers leave the profession at a higher rate than teachers of other subjects; furthermore, these investigators predict that teacher attrition rates will rise in the future as an increasing proportion of teachers reach retirement. Even given a 6 percent attrition rate, Grissmer and Kirby suggest that new demand for teachers could reach 9 percent per year because of enrollment and class size changes. Therefore, our estimate of 7.5 percent, or well over 20,000, seems a conservative estimate of yearly demand for new mathematics and science teachers.

Our work also shows that homemakers—although an important source of multiple-subject or liberal-arts teachers—may also prove to be a limited source of mathematics and science teachers. The fact that so few homemakers attended the special mathematics and science programs is not surprising given the fact that, historically, relatively small numbers of women have majored in math and science fields (Oakes, 1987). When women have majored in science, it has been primarily in biology, which has not experienced severe teacher shortages. Furthermore, homemakers are a shrinking pool from which to draw teachers, given the dramatic trend of women to stay in the workforce after having children.

The pools for which alternative preparation programs may have the most promise as a distinctive, long-lasting contribution are recent mathematics and science B.A.s and mid-career changers, since we found more programs that attracted these applicants than any other groups. Several programs we studied were attracting new mathematics and science B.A.s or mid-career changers after having unsuccessfully sought to recruit from other pools.

Mid-career changers present a unique challenge in recruitment, and they may be one of the likeliest major sources for programs such as those surveyed. For mid-career applicants, the special programs surveyed in this study may indeed provide incentives to enter teaching to those who would otherwise decide that the price of entry is too high.

Similarly, recent B.A.s who have not incurred significant financial burdens may be willing to enter teaching at an early point in their career if they believe that teaching jobs exist, that they will be paid a reasonable salary, and that entering teaching will not foreclose future options if they find teaching is not for them (Rothman, 1988). The University of Massachusetts, Amherst program, which trains new B.A.s for both public school teaching and industry, presents one unique model for providing these circumstances.

We suggest, however, that increasing salaries and providing better teacher working conditions would also be important incentives to recent B.A.s and the mid-career applicant—particularly considering the evidence that historically, mid-career scientists and engineers rarely enter teaching. As is frequently noted, the incentives for individuals trained in mathematics or science-related fields to enter or remain in teaching may be more tenuous than for other fields, where wage discrepancies and alternative job opportunities are less pronounced.

Costs to candidates may influence recruitment success. The programs we surveyed varied in their monetary costs to participants, ranging from free of charge to costing participants over $10,000 each. The Harvard program for mid-career changers was the most expensive program we encountered, yet it had over twice as many applicants as were accepted. Apparently, Harvard's prestige and preference for a moderately sized program

(20) contributes to this program's success at attracting sufficient numbers of highly qualified applicants. In contrast, retraining programs and alternative certification programs, which produce much larger numbers of mathematics and science teachers than do the smaller nontraditional recruitment programs at elite universities, have distinctive financial advantages for participants. These programs are often free of charge, or, in the case of many alternative certification programs, provide a regular teacher salary during much of training.

Programs differ considerably in the time and effort required to complete them as well. Nontraditional recruitment programs are similar to traditional teacher education programs—they generally involve a full-time commitment in coursework. At the other extreme, most alternative certification programs include a full-time, fully paid teaching internship. The additional time spent in teaching methods workshops and seminars is relatively minor when compared to the coursework required in standard certification programs.

The length of time required for program completion varied within program category as well as across categories. Retraining programs and district-based alternative certification programs required somewhat more calendar time for completion on average than the other program categories; this is partially because such programs are designed for part-time participation. In both cases, participants typically hold full-time teaching positions in addition to their formal coursework. Thus, the additional time required to complete this coursework is to be expected. The nontraditional recruitment programs and university-based alternative certification programs, on the other hand, usually involve full-time coursework and field placements. Although the total amount of time spent in formal coursework is greater for these programs, full-time attendance allows participants to complete most programs within 12 to 15 months.

In contrast to the longer time requirements of retraining programs, mid-career nontraditional recruitment programs have shown a tendency to shorten the calendar length of their programs of study, perhaps as an accommodation to participants who are anxious to begin earning money in their new occupation. Usually, alternative credentialing programs also feature quicker entry into mathematics and science teaching than do retraining programs.

The tremendous range of opportunity costs and financial costs found in our study suggests that the effects of these costs on recruitment are highly variable, depending on the circumstances of particular institutions and individuals. It appears that retraining programs so far have assumed that teachers are unwilling to assume tuition costs, and that a major incentive to enter alternative certification programs is to be able to assume teaching duties without having to take a substantial number of education courses beforehand. In contrast,

nontraditional recruitment programs have generally involved more coursework and slower entry into the teaching force. These higher costs are partly offset by financial aid programs and perhaps the prestige of getting a credential or master's degree at a college or university.

Programs also involve costs to sponsors and the institutions that house the training programs. Our survey did not collect data on these costs, so few inferences can be drawn. The data that indicate relatively high attrition rates for many retraining programs suggest that this option may be costly unless payment is made only for those who complete the program. However, it is noteworthy that most teachers who leave retraining programs do so by the end of the first course in the sequence. It is difficult to generalize about the institutional costs of nontraditional recruitment programs, since institutions vary widely in the expense of programs offered. Whereas retraining programs, and to a lesser extent, nontraditional recruitment programs, reflect primarily the costs of subject matter coursework, one of the largest direct costs of alternative certification programs borne by institutions is the cost of improved supervision for beginning teachers.

CHANGES IN PROGRAM DESIGN OR TARGET GROUPS

One observation from our study is that programs change and institutions adapt to new recruitment pools. Programs such as those at Washington University, Virginia Wesleyan University, and the University of Vermont all adapted when an original pool of applicants appeared insufficient to fill program slots. This tendency to shift recruitment to other types of applicants suggests that universities may need to maintain their flexibility in appealing to a wide range of nontraditional recruitment pools.

These data suggest that many programs—particularly IHE-based programs—which were directed to specific pools or subject matters tend to lose identity and become subsumed under regular programs over time. Some programs that originally focused on retirees but failed to recruit sufficient numbers from that pool, for example, have already turned to new B.A.s as a more ready source of applicants. Other programs that originally focused exclusively on mathematics and science have opened to applicants in other subject areas. The pressure to attract applicants from a wide range of sources to keep enrollment up, and the pressure to be responsive to quickly changing district needs (e.g., the need for mathematics and science teachers one year and the need for bilingual and elementary teachers the next), provide incentive to broaden the program's emphasis. This broadening of the program results in loss of identity with particular applicant pools or subject matters. This finding suggests that if teacher education programs are flexible in who they recruit and how they package themselves, they may do the same job as do alternative certification routes.

FACTORS INFLUENCING PROGRAM VIABILITY

This survey has pinpointed generalizations that can be made on the basis of program changes that we have noticed. The survey results suggest that several factors affect a program's enrollment and success in remaining viable:

- The state of the local or regional labor market,
- Local demand for mathematics and science teachers, and
- Program funding.

The Houston ACP program and the retiree programs show very clearly that recruit pools are difficult to measure in advance and are also highly unstable. Changes in unemployment rates appear to be particularly important in determining interest in the teaching profession: The Chevron program was a direct result of Chevron's early retirement program, which itself was a direct consequence of declining oil prices that created a need to lay off staff. The Houston shortage of math/science teachers disappeared relatively quickly when the local economy declined: The availability of math/science teaching jobs provided employment for engineers and scientists who saw little or no demand in industry, and undergraduates with math/science interests were also attracted to teaching because of a lack of opportunities in industry. The Washington University program, which at one time benefited from layoffs at Monsanto, now recruits fewer early retirees or career changers than before.

The local demand for mathematics and science teachers is another factor influencing programs. Enrollment in the Arizona PARTNER program decreased dramatically in the second year, partly because of a lack of a perceived mathematics and science shortage in local schools. The Houston ACP program dropped mathematics and science training after its first year because they were experiencing a much greater need for elementary and especially bilingual instructors; in addition, Houston filled some of its mathematics/science vacancies by providing emergency certification to candidates.

Funding is another major factor in program viability. Several of the nontraditional programs have recently ended, because of a lack of funding. Many of the federally funded Hellman programs, for example, closed after one or two years of operation; only those that succeeded in finding alternative sources of funding have continued to retrain teachers. The University of Bridgeport is another program that ended because of lack of funding, although its regular program continued to attract mid-career applicants after the demise of the more focused project.

These observations of program changes suggest several generalizations about which programs are most likely to thrive:

1. Programs may be most successful at attracting new mathematics and science teachers in times of high or rising unemployment in math/science-related fields outside of education.
2. Programs may be more likely to survive if they are planned with a clear understanding of the needs of local school districts.
3. Programs may be more likely to survive if they are flexible in targeting recruit pools and can be supported by regular teacher education programs.
4. Programs may be more likely to survive if they have stable sources of funding.

OPTIONS FOR ALLEVIATING MATHEMATICS AND SCIENCE TEACHER SHORTAGES

The small size of the programs surveyed here, and their tendency to broaden in focus, suggests several options for dealing with the ongoing lack of qualified mathematics and science teachers. First, the relatively large number of emergency and out-of-field assignments (Council for Basic Education, 1985; Roth, 1986; Weiss, 1987), many of which may prove to be less than temporary, suggests that retraining programs provide a promising way of increasing math/science teaching quality in the short run. Most districts have been able to fill teaching vacancies with college graduates. The major problem appears to be lack of qualification to teach mathematics or science. Large-scale district-based retraining programs—part-time, local classes—combined with a system of master teachers providing school-based oversight and assistance to out-of-field teachers would appear to provide a means of improving teaching quality given the large numbers of out-of-field teachers.

The retraining option has several drawbacks. First, New York City Math/Science Relicensing, Arizona State Hellman Academy, and other programs have found that a large percentage of teachers drop out of retraining. This suggests that retraining programs may attract large numbers at the beginning but prove inefficient in ultimately producing new mathematics and science teachers. Second, even when teachers successfully complete a program, there is no assurance that they will seek or find appropriate mathematics and science openings—recent evidence suggests that the record of placing retrained teachers in their new subjects varies considerably across programs (Adelman, 1986). Last, large-scale retraining programs require considerable effort on the part of teachers, as well as additional expense to districts already faced with lean budgets.

A second option would be to improve the quality of alternative certification training and support for beginning teachers. Alternative certification programs tend to be relatively large and have a dispersed effect across the states that adopt them. Some of the ACP programs we surveyed included better support for beginning teachers. Better support for beginning teachers—including mathematics and science teachers— would make sense, especially given evidence that the first few years are when teachers learn the most about the profession (Wise et al., 1987). Furthermore, the first few years are when most teachers who will leave the profession before retirement do so (Grissmer and Kirby, 1987). The negative side of alternative certification programs is that they offer less classroom-based pedagogical training and establish two routes to certification. Without the improved supervision of participants that we witnessed in some ACP programs, the training these programs provide can be little better than that accorded emergency credentialees. The long-run effects of ACPs are still a matter of conjecture.

A third option would be to restructure graduate teacher education programs so that they market to a broader clientele via nontraditional recruitment programs. This trend may already be occurring, as many of the teacher education programs surveyed here have broadened as part of their efforts to better serve potential applicants and the districts where student teachers are placed. This option has the advantage of placing responsibility for alleviating teacher shortages in institutions with long-term interest and experience in training teachers. However, there is a question whether teacher education programs will be as successful in attracting some of the people now tapped primarily by ACPs without significant changes designed to appeal to these potential teachers.

A fourth option would be to restructure the teaching profession to make it permanently more attractive to the largest potential recruit pools. Demographically, the largest and fastest growing segments of new recruit pools for mathematics and science teachers are mid-career applicants and retirees; these groups may be particularly sensitive to teacher working conditions. Furthermore, new B.A.s with mathematics and science degrees—a large but not growing pool—are sought by industry with higher potential salaries. This suggests that, over the long-term, new B.A.s will need higher salaries if they are to be attracted to mathematics and science teaching in large numbers.

The recruitment pool for which alternative preparation programs may have the most promise as a distinctive, long-lasting contribution, are the mid-career changers, since we found more programs that emphasized these applicants than any other group. These people may fear the financial and opportunity costs of entering teaching, and may be the likeliest major source for programs such as those surveyed. For mid-career applicants, the special

programs surveyed in this study may provide incentive to enter teaching to those who would otherwise decide that the price of entry is too high.

We suggest, however, that increasing teacher salaries may also provide important incentives to the mid-career applicant—particularly considering the evidence that historically, mid-career scientists and engineers rarely enter teaching.

A final observation is that the programs surveyed here change or end rapidly when there are shifts in local demand, funding, or the availability of qualified applicants. Longevity should not be the sole criterion of program success, given our evidence that programs often are assimilated into ongoing efforts or serve as springboards to related programs. But the question remains whether most nontraditional programs are essentially temporary initiatives, or whether they will provide a long-term solution to the problem of attracting qualified mathematics and science teachers. We speculate that the types of programs surveyed will attract nontrivial numbers of new teachers but will not solve the long-term shortage of qualified mathematics and science teachers in the absence of other major policy changes designed to make the profession more attractive.

Appendix

Copy of letter and data form mailed to program directors.

Program Director
Program Name
Institution Name
Address
City, State Zip Code

Dear Program Director:

As part of our study of New Recruits into Math and Science Teaching, The RAND Corporation recently conducted a telephone survey of alternative teacher preparation programs. Your program was included in our survey sample.

The enclosed table summarizes the information we have obtained thus far. Please note that this table is in draft form only, and may contain errors. The one-page form shows the information we currently have on your program, based on a conversation with you or a member of your staff. In order to insure the accuracy of our report, would you kindly take the time to review this information, correcting any errors or adding any missing information? The comprehensiveness and accuracy of this information is important to the quality of our report and its usefulness to policy makers and other program directors. We have enclosed a stamped, self-addressed envelope for your convenience in returning the form to us.

Thank you very much for your participation in our research. We look forward to sharing our results with you when our final report is completed.

Sincerely,

Neil Carey
Associate Behavioral Scientist

Brian Mittman
Associate Social Scientist

Enclosures

The RAND Corporation

1987 Ford Foundation Study of New Recruits into Math and Science Teaching

Survey of Alternative Teacher Preparation Programs

Name of Program: _____

Year Program Began: _____

Current Enrollment: _____
(Include only participants seeking training in math or science)

Program Outcome (check one):

___ Regular Certification (meets traditional certification requirements)
___ Alternative Certification (involves non-traditional certification requirements, such as earlier classroom responsibility and reduced formal education coursework)
___ Other (Please explain)_____

Typical Length of Time for Program Completion: _____

Typical Annual Program Cost to Participants: _____

Approximate Percentage of Currently Enrolled Participants Who Are:
_____ Recent math/science B.A.s
_____ Mid-Career changers
_____ Retirees
_____ Current teachers desiring math/science certification
_____ Discharged military personnel (or soon to be discharged)
_____ Homemakers

Have there been any recent changes in the program and/or enrollment? If so, what changes have occurred and why?

_____

_____

_____

_____

REFERENCES

Adelman, N. E., *An Exploratory Study of Teacher Alternative Certification and Retraining Programs*, Policy Studies Associates, Washington, D.C., 1986.

American Association of Colleges for Teacher Education (AACTE), *Teacher Education Policy in the States. 50-State Survey of Legislative and Administrative Actions*, Washington, D.C., 1986.

Association for School, College, and University Staffing (ASCUS), *Teacher Supply/Demand 1986*, Madison, WI, 1986.

Boyer, E. L., *High School: A Report on Secondary Education in America*, Harper and Row, New York, 1983.

Carnegie Forum on Education and the Economy, *A Nation Prepared: Teachers for the 21st Century*, Washington, D.C., 1986.

Center for Education Statistics (CES), *Digest of Education Statistics, 1987*, U.S. Department of Education, Washington, D.C., 1987.

Center for Education Statistics (CES), *Projections of Education Statistics to 1992-93*, U.S. Department of Education, Washington, D.C., 1985.

Coley, R. J., and M. E. Thorpe, *Responding to the Crisis in Math and Science Teaching: Four Initiatives*, Educational Testing Service, Princeton, N.J., 1985a.

Coley, R. J., and M. E. Thorpe, *A Look at the MAT Model of Teacher Education and Its Graduates: Lessons for Today*, Educational Testing Service, Princeton, N.J., 1985b.

Commission on Teacher Credentialing, *The Effectiveness of the Teacher Trainee Program: An Alternative Route into Teaching in California*, California Legislature Commission on Teacher Credentialing, Sacramento, CA, 1987.

Cooper, Bruce S., "Retooling Teachers: The New York Experience," *Phi Delta Kappan*, Vol. 68, 1987, pp. 606-609.

Council for Basic Education and the American Federation of Teachers, *Making Do in the Classroom: A Report on the Misassignment of Teachers*, Council for Basic Education and the American Federation of Teachers, Washington, D.C., 1985.

Darling-Hammond, L., *Beyond the Commission Reports: The Coming Crisis in Teaching*, The RAND Corporation, R-3177-RC, July 1984.

Darling-Hammond, L., and B. Berry, *The Evolution of Teacher Policy*, The RAND Corporation., JRE-01, March 1988.

Darling-Hammond, L., and L. Hudson, *Precollege Science and Mathematics Teachers: Supply, Demand, and Quality*, paper prepared for the National Science Foundation, 1987.

Education Week, "Shortages of '85 Vanish As Schools Hire Uncertified Teachers," September 25, 1985.

Education Week, "Teacher-Training Enrollment Surging Upward, Poll Finds," March 2, 1988, pp. 1, 26.

Feistritzer, E. C., *Teacher Crisis: Myth or Reality?*, National Center for Educational Information, Washington, D.C., 1986.

Fox, S. R., *Scientists in the Classroom: Two Strategies*, National Institute for Work and Learning, Washington, D.C., 1986.

Grissmer, D. W., and S. Kirby, *Teacher Attrition: The Uphill Climb To Staff the Nation's Schools*, The RAND Corporation, R-3512-CSTP, August 1987.

Hawley, W. D., "Toward a Comprehensive Strategy for Addressing the Teacher Shortage," *Phi Delta Kappan*, Vol. 67, 1986, pp. 712-718.

Howe, T. G., and J. A. Gerlovich, "National Study of the Estimated Supply and Demand of Secondary Science and Mathematics Teachers" (working document), Iowa State University, Ames, IA, 1982.

Kershaw, J. A., and R. N. McKean, *Teacher Shortages and Salary Schedules*, McGraw-Hill, New York, 1962.

Klausmeier, Robert, "Lessons from the Past," *Action in Teacher Education*, Vol. 9, 1987, pp. 9-20.

Levin, H.M., "Solving the Shortage of Mathematics and Science Teachers," *Educational Evaluation and Policy Analysis*, Vol. 7, 1985, pp. 371-382.

National Center for Education Information, *Teacher Certification Survey*, Washington, D.C., 1986.

National Commission on Excellence in Education, *A Nation At Risk*, U.S. Government Printing Office, Washington, D.C., 1983.

National Education Association (NEA), *Status of the American Public School Teacher: 1985-86*, Washington, D.C., 1987.

National Education Association (NEA), *Nationwide Teacher Opinion Poll*, Washington, D.C., 1983.

National Science Board, Commission on Precollege Education in Mathematics, Science, and Technology, *Educating Americans for the 21st Century*, Washington, D.C., 1983.

Oakes, J., "Opportunities, Achievement, and Choice: Issues in the Participation of Women, Minorities, and the Disabled in Science," paper prepared for the National Science Foundation, 1987.

Plisko, V. W., "Teacher Preparation," in V. W. Plisko (ed.), *The Condition of Education*, 1983 Edition, U.S. Government Printing Office, Washington, D.C., 1983.

Ramo, S., *What's Wrong with Our Technological Society: And How to Fix It*, McGraw-Hill, New York, 1983.

Roth, R. A., "Emergency Certificates, Misassignment of Teachers, and Other 'Dirty Little Secrets'," *Phi Delta Kappan*, 1986, pp. 725-727.

Rothman, R., "Proportion of College Freshmen Interested in a Career in Teaching Up, Survey Finds," *Education Week*, January 20,1988, p. 5.

Rumberger, Russell, "The Shortage of Mathematics and Science Teachers: A Review of the Evidence," *Educational Evaluation and Policy Analysis*, Vol. 7, 1985, pp. 355-369.

Schechter, E., *The New Jersey Provisional Teacher Program: A Third Year Report*, New Jersey State Department of Education, Trenton, NJ, 1987.

Sedlak, M., and S. Schlossman, *Who Will Teach? Historical Perspectives on the Changing Appeal of Teaching As a Profession*, The RAND Corporation, R-3472-CSTP, November 1986.

Shymansky, J., and B. Aldridge, "The Teacher Crisis in Secondary School Science and Mathematics," *Educational Leadership*, 1982, pp. 61-62.

Southern Regional Education Board, "Serious Shortages of Science and Mathematics Teachers: What SREB States Are Doing," *Regional Spotlight, News of Education in SREB States*, Southern Regional Education Board, Atlanta, GA, 1986.

Vance, V. S., and P. C. Schlechty, "The Distribution of Academic Ability in the Teaching Force: Policy Implications," *Phi Delta Kappan*, Vol. 64, 1982, pp. 22-27.

Weaver, W. Timothy, "Educators in Supply and Demand: Effects on Quality," *School Review*, Vol. 86, 1978, pp. 553-593.

Weiss, I. R., *How Well Prepared Are Science and Mathematics Teachers? Results of the 1985-86 National Survey of Science and Mathematics Education*, paper presented at the annual meeting of the American Educational Research Association, Washington, D.C., 1987.

Wise, A. E., L. Darling-Hammond, and B. Berry, *Effective Teacher Selection: From Recruitment to Retention*, The RAND Corporation, R-3462-NIE/CSTP, January 1987.